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ABSTRACT

This instructor guide and the corresponding student reference contain 12 units, which cover the following topics: (1) opportunities in the landscaping and turfgrass industries; (2) how plants grow; (3) plant identification; (4) hand and power tools (identification and maintenance); (5) pesticides; (6) installation and maintenance of trees and shrubs; (7) installation and maintenance of bedding plants and ground covers; (8) turfgrass; (9) site analysis and evaluation; (10) plant identification and selection; (11) design elements; and (12) cost estimates. This material is designed to be taught to junior and senior high or vocational school students as a 1-year course. In the instructor's guide, each lesson in a unit contains some or all of the following: objective, study questions, references, teaching outline, student test with answers, transparency masters, job sheets, and assignment sheets. Plant identification and selection tables are located in the student reference. (NLA)

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Landscaping and Turf Management

Instructor Guide

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In cooperation with
Agricultural Education
Department of Practical Arts
and Vocational-Technical Education
College of Education and College of Agriculture
University of Missouri-Columbia

In cooperation with
Agricultural Education Section
Division of Vocational and Adult Education
Department of
Elementary and Secondary Education
Jefferson City, Missouri

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Instructor Guide

LANDSCAPING AND TURF MANAGEMENT

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FOREWORD

The development of the Landscaping and Turf Management guide is the result of suggestions by the MVATA Teaching Aids Committee. The Landscaping and Turf Management Advisory Committee suggested the topics to be discussed and reviewed the materials.

This instructor guide and the corresponding student reference contain 12 units, which cover a wide range of topics including: opportunities in the landscaping and turfgrass industries; how plants grow; hand and power tools; installation and maintenance of trees, shrubs, bedding plants, and ground covers; turfgrass; site analysis and evaluation; plant identification and selection; design elements; and cost estimates. See the table of contents for a detailed listing. This material is designed to be taught to juniors and seniors as a one-year course. Transparency masters, job sheets, and assignment sheets have been included where appropriate. Plant identitification and selection tables are located only in the student reference.

During the summer of 1981, the Missouri State Board of Education formally adopted the concept of "Instructional Management Systems" (IMS) as a priority for the 1981-82 school year. The Missouri Commissioner of Education described the IMS concept as a practical way of "organizing for excellence" in education. To meet the demand for greater productivity and accountability, Dr. Frank Drake, Director of Vocational Education, applied the elements of IMS to form the Vocational Instructional Management System (VIMS). The VIMS process provides a framework to use in planning and organizing to assure excellence in Missouri's vocational education system by focusing greater attention on the management of teaching and learning.

This guide incorporates the needed component parts to aid agriculture teachers in the implementation of VIMS. For ease of use, performance objectives and competencies have been included at the beginning of the guide, as well as being incorporated within each lesson. A competency profile has been provided for convenient record keeping.

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LANDSCAPING AND TURF MANAGEMENT

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OBJECTIVES

UNIT I - EVALUATING OPPORTUNITIES IN THE LANDSCAPING AND TURFGRASS INDUSTRIES

1. The student will be able to explain the importance of landscape and turfgrass industries today and in the future.
2. The student will be able to describe the common jobs in the landscape and turfgrass industries.

UNIT II - HOW PLANTS GROW

1. The student will be able to demonstrate knowledge of the difference between monocot and dicot plants and how they differ in growth patterns.
2. The student will be able to demonstrate knowledge of the soil factors affecting plant growth, and how to improve the soil.
3. The student will be able to describe environmental climatic factors that affect plants.

UNIT III - IDENTIFICATION

1. The student will be able to demonstrate a knowledge of the characteristics of plants which will aid in plant identification.
2. The student will be able to describe the identifying characteristics of narrow-leaf evergreens.
3. The student will be able to identify selected shade, flowering, and evergreen trees.
4. The student will be able to identify selected flowering and evergreen shrubs.

5. The student will be able to identify selected vines, ground covers, and perennials commonly used in the landscape.
6. The student will be able to identify the characteristics of grasses used in identification.
7. The student will be able to identify the six major turfgrasses used in Missouri.

UNIT IV - TOOL IDENTIFICATION AND MAINTENANCE

1. The student will be able to identify and maintain the common hand tools used in the landscape and turfgrass industries.
2. The student will be able to identify and maintain common power tools used in the landscape and turfgrass industries.

UNIT V - PESTICIDES

1. The student will be able to describe how various types of pesticides work.
2. The student will be able to accurately read and interpret pesticide labels.
3. The student will be able to identify safety precautions that should be followed when mixing, applying, storing, and disposing of pesticides.

UNIT VI - INSTALLATION AND MAINTENANCE OF TREES AND SHRUBS

1. The student will be able to describe procedures for planting and transplanting balled and burlapped, container-grown, and bare-root trees, and shrubs.
2. The student will be able to describe procedures to care for newly-transplanted trees and shrubs.
3. The student will be able to prune evergreens, deciduous trees, shrubs, hedges, and roses.
4. The student will be able to explain how to determine the nutrients needed by plants, their function in plants, symptoms of deficiency, and how to use a fertilizer label.
5. The student will be able to determine when and how much to irrigate and what methods to use.
6. The student will be able to recognize and know control methods for common and destructive insects and diseases.

UNIT VII - INSTALLATION AND MAINTENANCE OF BEDDING PLANTS AND GROUND COVERS

1. The student will be able to transplant bedding plants and ground covers.
2. The student will be able to maintain bedding plants and ground covers.

UNIT VIII - TURFGRASS

1. The student will be able to explain the growth habits of turfgrass, its seasons of growth, and advantages and disadvantages of different turfgrasses.
2. The student will be able to describe the procedure for installing a lawn.
3. The student will be able to successfully water, fertilize, and mow turfgrass.
4. The student will be able to explain how to take a failing, established lawn and either cultivate or renovate it.
5. The student will be able to identify common weeds, insects, and diseases that damage the turf; and explain how these pests are controlled.

UNIT IX - SITE ANALYSIS AND EVALUATION

1. The student will be able to analyze a landscape site.
2. The student will be able to accurately measure a landscape site and draw a base map to scale.
3. The student will be able to effectively use symbols on a landscape plan.

UNIT X - SELECTING AND USING PLANTS IN THE LANDSCAPE

1. The student will be able to describe the purposes of trees in the landscape and factors considered in selecting trees.
2. The student will be able to select shrubs or hedges to fulfill desired purposes in a landscape plan.
3. The student will be able to select vines and ground covers for effective use in a landscape.

4. The student will be able to describe the purposes of flowers and how to select flowers for the landscape.
5. The student will be able to describe the purpose of turfgrass in landscaping and the criteria to consider when selecting a turfgrass.

UNIT XI - LANDSCAPE DESIGNING

1. The student will be able to identify and explain the four elements of landscape design.
2. The student will be able to implement the use of natural and manufactured materials in a landscape plan.
3. The student will be able to identify the five principles of design.
4. The student will be able to combine design elements and principles to create a landscape plan.
5. The student will be able to develop a complete landscape plan.

UNIT XII - DEVELOPING COST ESTIMATES

1. The student will be able to figure a cost analysis.
2. The student will be able to price the various components of landscape maintenance.

NOTE: Percent of accuracy should be set by instructors to reflect passing grades within their school systems.

COMPETENCIES

UNIT I - EVALUATING OPPORTUNITIES IN THE LANDSCAPING AND TURFGRASS INDUSTRIES

1. Explain the importance of landscaping and turfgrass industries today and in the future.
2. Identify and describe landscape and turfgrass jobs.

UNIT II - HOW PLANTS GROW

1. Label plant parts and structures correctly and identify the differing growth patterns of monocot and dicot plants.
2. Demonstrate knowledge of soil properties and how soil quality relates to plant growth; assess the soil at a planting site and determine how to improve it, if needed.
3. Describe environmental factors that should be considered before selecting a plant for the landscape.

UNIT III - IDENTIFICATION

1. Identify the basic structural features of trees and shrubs.
2. Identify the distinguishing characteristics for common narrow-leaf evergreens.
3. Identify selected trees.
4. Identify selected shrubs.
5. Identify ground covers, vines, and perennials.
6. Identify characteristics of grasses.
7. Identify the six major turfgrasses used in Missouri.

UNIT IV - TOOL IDENTIFICATION AND MAINTENANCE

1. Identify and maintain hand tools and equipment.
2. Identify, maintain, and safely use power tools.

UNIT V - PESTICIDES

1. Describe how various types of pesticides work.
2. Accurately interpret a pesticide label for information about use, effectiveness, and safe handling.
3. Identify safety precautions that should be followed when using pesticides.

UNIT VI - INSTALLATION AND MAINTENANCE OF TREES AND SHRUBS

1. Transplant a tree or shrub and properly plant a bare-root, container-grown, or B and B tree or shrub.
2. Stake and guy a newly-planted tree; wrap, prune, and apply anti-transpirants to young tree.
3. Prune trees, shrubs, hedges, and roses.
4. Fertilize trees and shrubs.
5. Determine the best methods of irrigation in various situations.
6. Recognize common insects and diseases, the type of damage or symptoms they cause, and recommended control methods.

UNIT VII - INSTALLATION AND MAINTENANCE OF BEDDING PLANTS AND GROUND COVERS

1. Prepare the soil of a flower bed, determine the number of plants to use, and transplant bedding plants and ground covers.
2. Maintain bedding plants and ground covers.

UNIT VIII - TURFGRASS

1. List advantages and disadvantages of the six major turfgrasses grown in Missouri.
2. Describe the procedure for installing a lawn.
3. Maintain turf by properly fertilizing, watering, and mowing.
4. Explain how to successfully cultivate or renovate a lawn.
5. Identify common pests in turfgrass and explain how to control these pests.

UNIT IX - SITE ANALYSIS AND EVALUATION

1. Analyze a landscape site.
2. Draw a base map to scale.
3. Effectively use design symbols in a landscape plan.

UNIT X - SELECTING AND USING PLANTS IN THE LANDSCAPE

1. Select trees for specific purposes in the landscape.
2. Select effective shrubs and hedges for landscape.
3. Describe the uses of vines and ground covers and select the species to suit the location to be planted.
4. Select a location and plants for a perennial bed or border.
5. Select a turfgrass for a specific growing site.

UNIT XI - LANDSCAPE DESIGNING

1. Identify and explain the four elements of landscape design.
2. Implement the use of natural and manufactured enrichments in a landscape plan.
3. Identify the five principles of design.
4. Apply both the principles and elements of design to create a landscape plan.

UNIT XII - DEVELOPING COST ESTIMATES

1. Calculate the price of a landscape design.
2. Price various components of landscape maintenance.

MOTIVATIONAL TECHNIQUE OR INTEREST APPROACH

1. Invite an owner of a landscape business to bring in samples of completed designs. Ask the individual to demonstrate drawing techniques used on the plan. If possible, ask the individual to display several projects in various stages of completion.

2. Tour a few well-landscaped lawns of homes or businesses in the area. Point out to the students that they will be studying many of the techniques required in landscaping.

3. If possible, display a model for a future home or business. Point out how planning is the first step in building anything, including the landscape. (A landscape business in the area may have models.)

EVALUATION

1. Give short, objective tests following each lesson and a more indepth objective test at the conclusion of the unit.

2. Observe the changes in behavior as evidence of an improved ability of students to deal with problems in this unit using background information acquired from earlier units.

3. Observe students' attempts to solve similar problems in their supervised agricultural experience programs.

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b. Audiovisuals
(Available from the Missouri Vocational Resource Center, University of Missouri-Columbia, 8 London Hall, Columbia, MO 65211)

1) Ground Covers. video. Morris Video.

2) Growing Beautiful Lawns. video. Ortho.

3) Elements of Pruning. video. Vocational Education Productions

4) Ornamental Annual Plants and Their Uses. slides with script. Ohio Agricultural Education Curriculum Materials Service.

5) Selected Landscape Plants. slides with script. Ohio Agricultural Education Curriculum Materials Service.

c. Audiovisuals
(Available from the Instructional Materials Laboratory, 10 London Hall, Columbia, MO 65211.)

1) Diseases of Landscape Ornamentals. slides with script. Ohio Agricultural Education Materials Service.

2) Landscape Design. slides with script. Ohio Agricultural Materials Service.

3) Nursery/Landscaping Identification. slides with tape. Instructional Materials Laboratory.

LANDSCAPING AND TURF MANAGEMENT
Major Competency Profile

Directions: Evaluate the student by checking the appropriate number or letter to indicate the degree of competency. The rating for each task should reflect **employability readiness** rather than the grades given in class.

Rating Scale: 3 **Mastered** - can work independently with no supervision
2 **Requires Supervision** - can perform job completely with limited supervision
1 **Not Mastered** - requires instruction and close supervision
N **No Exposure** - no experience or knowledge in this area

3	2	1	N	
▨	▨	▨	▨	**Unit I - Evaluating Opportunities in the Landscaping and Turfgrass Industries**
				1. Explain the importance of landscaping and turfgrass industries today and in the future.
				2. Identify and describe landscape and turfgrass jobs.
▨	▨	▨	▨	**Unit II - How Plants Grow**
				1. Label plant parts and structures correctly and identify the differing growth patterns of monocot and dicot plants.
				2. Demonstrate knowledge of soil properties and how soil quality relates to plant growth; assess the soil at a planting site and determine how to improve it, if needed.
				3. Describe environmental factors that should be considered before selecting a plant for the landscape.
▨	▨	▨	▨	**Unit III - Identification**
				1. Identify the basic structural features of trees and shrubs.
				2. Identify the distinguishing characteristics for common narrow-leaf evergreens.
				3. Identify selected trees.
				4. Identify selected shrubs.
				5. Identify ground covers, vines, and perennials.
				6. Identify characteristics of grasses.
				7. Identify the six major turfgrasses used in Missouri.
▨	▨	▨	▨	**Unit IV - Tool Identification and Maintenance**
				1. Identify and maintain hand tools and equipment.
				2. Identify, maintain, and safely use power tools.
▨	▨	▨	▨	**Unit V - Pesticides**
				1. Describe how various types of pesticides work.
				2. Accurately interpret a pesticide label for information about use, effectiveness, and safe handling.
				3. Identify safety precautions that should be followed when using pesticides.
▨	▨	▨	▨	**Unit VI - Installation and Maintenance of Trees and Shrubs**
				1. Transplant a tree or shrub and properly plant a bare-root, container-grown, or B and B tree or shrub.
				2. Stake and guy a newly-planted tree; wrap, prune, and apply anti-transpirants to young trees.
				3. Prune trees, shrubs, hedges, and roses.
				4. Fertilize trees and shrubs.
				5. Determine the best methods of irrigation in various situations.
				6. Recognize common insects and diseases, the type of damage or symptoms they cause, and recommended control methods.

3	2	1	N	
▨	▨	▨	▨	**Unit VII - Installation and Maintenance of Bedding Plants and Ground Covers**
				1. Prepare the soil of a flower bed, determine the number of plants to use, and transplant bedding plants and ground covers.
				2. Maintain bedding plants and ground covers.
▨	▨	▨	▨	**Unit VIII - Turfgrass**
				1. List advantages and disadvantages of the six major turfgrasses grown in Missouri
				2. Describe the procedure for installing a lawn.
				3. Maintain turf by properly fertilizing, watering, and mowing.
				4. Explain how to successfully cultivate or renovate a lawn.
				5. Identify common pests in turfgrass and explain how to control these pests.
▨	▨	▨	▨	**Unit IX - Site Analysis and Evaluation**
				1. Analyze a landscape site.
				2. Draw a base map to scale.
				3. Effectively use design symbols in a landscape plan.
▨	▨	▨	▨	**Unit X - Selecting and Using Plants in the Landscape**
				1. Select trees for specific purposes in the landscape.
				2. Select effective shrubs and hedges for landscape.
				3. Describe the uses of vines and ground covers and select the species to suit the location to be planted.
				4. Select a location and plants for a perennial bed or border.
				5. Select a turfgrass for a specific growing site.
▨	▨	▨	▨	**Unit XI - Landscape Designing**
				1. Identify and explain the four elements of landscape design.
				2. Implement the use of natural and manufactured enrichments in a landscape plan.
				3. Identify the five principles of design.
				4. Apply both the principles and elements of design to create a landscape plan.
▨	▨	▨	▨	**Unit XII - Developing Cost Estimates**
				1. Calculate the price of a landscape design.
				2. Price various components of landscape maintenance.

Landscaping and Turf Management

Class/Section: ____________________

Students:															
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Landscaping and Turf Management (Cont'd)

Class/Section: ____________________

Students:

Unit VII - Installation and Maintenance of Bedding Plants and Ground Covers

1. Prepare the soil of a flower bed, determine the number of plants to use, and transplant bedding plants and ground covers.
2. Maintain bedding plants and ground covers.

Unit VIII - Turfgrass

1. List advantages and disadvantages of the six major turfgrasses grown in Missouri
2. Describe the procedure for installing a lawn.
3. Maintain turf by properly fertilizing, watering, and mowing.
4. Explain how to successfully cultivate or renovate a lawn.
5. Identify common pests in turfgrass and explain how to control these pests.

Unit IX - Site Analysis and Evaluation

1. Analyze a landscape site.
2. Draw a base map to scale.
3. Effectively use design symbols in a landscape plan.

Unit X - Selecting and Using Plants in the Landscape

1. Select trees for specific purposes in the landscape.
2. Select effective shrubs and hedges for landscape.
3. Describe the uses of vines and ground covers and select the species to suit the location to be planted.
4. Select a location and plants for a perennial bed or border.
5. Select a turfgrass for a specific growing site.

Unit XI - Landscape Designing

1. Identify and explain the four elements of landscape design.
2. Implement the use of natural and manufactured enrichments in a landscape plan.
3. Identify the five principles of design.
4. Apply both the principles and elements of design to create a landscape plan.

Unit XII - Developing Cost Estimates

1. Calculate the price of a landscape design.
2. Price various components of landscape maintenance.

UNIT I - EVALUATING OPPORTUNITIES IN THE LANDSCAPE AND TURFGRASS INDUSTRIES

Lesson 1: The Importance of Landscaping

Objective: The student will be able to explain the importance of landscape and turfgrass industries today and in the future.

Study Questions

1. **How do plants affect people and their environment?**
2. **What effect does landscaping have on property values?**
3. **What is the economic value of the landscape and turfgrass industries to the nation?**
4. **What determines the future of the landscape and turfgrass industries?**

Reference

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.

UNIT I - EVALUATING OPPORTUNITIES IN THE LANDSCAPE AND TURFGRASS INDUSTRIES

Lesson 1: The Importance of Landscaping

TEACHING PROCEDURES

A. Introduction

Landscape and turfgrass industries are growing and will continue to grow as their services remain in high demand. More individuals, communities, cities, and states are turning to the landscape and turfgrass industries to improve the appearance of as well as to increase the economic value of their environments.

B. Motivation

Jobs in landscape design, landscape maintenance, and turf management will be in higher demand in the future.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students if they notice homes and buildings that are landscaped and those that are not landscaped.

   How do plants affect people and their environment?

   Plants may cause psychologically uplifting effects on people, as well as create long-range improvements in the environment.

2. Ask students to compare the appearance of a home that is not landscaped to a similar home that is landscaped.

   What effect does landscaping have on property values?

   a) Increases the beauty of the property
   b) Adds security to the property
   c) Is a capital investment
   d) May help save energy in home heating and cooling

3. Ask students if they think landscaping has had an economic effect on the nation.

   What is the economic value of the landscape and turfgrass industries to the nation?

   a) It has been increasing steadily since the 1960's.
   b) It has generated from under one billion dollars to over seven billion dollars within the past seven years.

4. Ask students if their parents have time to maintain their yards. If their parents do not have time, do they hire someone to do the job? Ask students if they have computers at home and how computers might benefit landscape and turfgrass industries in the future.

   What determines the future of the landscape and turfgrass industries?

   a) More people will be working from their homes with the increase of electronics, computers, and telecommunication.
   b) More retirement homes will be needed.
   c) More condominiums are being built for a growing, single adult population.
   d) Theme parks, shopping centers, and malls will require increased services from landscape and turfgrass industries.

F. Other activities

1. Invite a quest speaker in to talk about landscape and turfgrass industries.

2. Take students on a field trip to tour a landscape or turfgrass industry.

G. Conclusion

Landscape and turfgrass industries are important service industries today, and will continue to expand in the future.

H. Competency

Explain the importance of landscape and turfgrass industries today and in the future.

I. Answers to Evaluation

1. b
2. b
3. b
4. c

5. Answers should contain three of the following:
   a. Relaxation
   b. Psychologically uplifting
   c. Give feeling of pride
   d. Place of refuge
   e. Place for entertaining

UNIT I - EVALUATING OPPORTUNITIES IN THE LANDSCAPE AND TURFGRASS INDUSTRIES

Name ____________________

Date ____________________

Lesson 1: The Importance of Landscaping

EVALUATION

Circle the letter that corresponds to the best answer.

1. Landscaping adds approximately what percentage to property value?

   a. 0-5
   b. 10-15
   c. 20-25
   d. 30-35

2. How can landscaping increase property value?

   a. Securing the family dog behind a fence
   b. Adding security through screening and fencing
   c. Blocking neighbor's view
   d. Making the house appear smaller

3. What do recent surveys claim about landscaping?

   a. A field of the past
   b. An important field of the future
   c. Not an important field of the past
   d. Not an important field of the future

4. Which describes growth of the economic value of the landscape and turfgrass industries?

   a. Increasing slowly
   b. Decreasing slowly
   c. Increasing steadily
   d. Decreasing steadily

Complete the following short answer question.

5. What are three effects that plants can have on people and their environments?

   a.

   b.

   c.

UNIT I - EVALUATING OPPORTUNITIES IN THE LANDSCAPE AND TURFGRASS INDUSTRIES

Lesson 2: Careers and Professional Organizations in the Landscape and Turfgrass Industries

Objective: The student will be able to describe the common jobs in the landscape and turfgrass industries.

Study Questions

1. **What are some common jobs in the landscape and turfgrass industries?**
2. **How can a landscape or turfgrass job be found?**
3. **What are some possible SAEP's for landscaping and turf management?**
4. **What are some benefits of professional organizations?**
5. **Why is it important to subscribe to trade publications?**

Reference

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.

Lesson 2: Careers and Professional Organizations in the Landscape and Turfgrass Industries

TEACHING PROCEDURE

A. Review

Review previous lesson.

B. Motivation

Explain that many future jobs will be service jobs. Landscape and turfgrass industries will be expanding because they provide service jobs which will be in high demand.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students to list all the jobs they think could be included in the landscape and/or turfgrass industries. Ask students to discuss those jobs listed in which they might like to be employed and why.

   What are some common jobs in the landscape and turfgrass industries?

   a) Landscape architect/designer
   b) Landscape maintenance
   c) Golf course employee
   d) Landscape gardener
   e) Garden center employee
   f) Horticulture teacher
   g) Parks system foreman
   h) Tree maintenance foreman
   i) Horticulture extension agent
   j) Research specialist
   k) Plant breeder

2. Ask students how they would find a place, such as a restaurant, where they have never been.

   How can a landscape or turfgrass job be found?

   a) Yellow pages
   b) Newspaper advertisements
   c) Trade journals
   d) Word-of-mouth
   e) Employment agencies
   f) School guidance or placement
   g) Horticulture teacher
   h) Friends and relatives
   i) Horticulture firms and businesses

3. Ask students why hands-on experiences would be an effective way to learn landscaping and turf management skills.

   What are some possible SAEP's for landscaping and turf management?

   a) Mowing and other summer maintenance jobs
   b) Creating and implementing landscape designs
   c) Raking leaves in fall and other maintenance jobs for winterization of plants
   d) Maintaining lawn equipment for individuals in the community
   e) "Lawn sitting" for homeowners on vacation
   f) Performing jobs at a local nursery, garden center, or golf course
   g) Snow plowing and shoveling during winter

4. Ask students what kinds of benefits they might receive from being a member of 4-H, a football team, a pep club, an honor society, or a band.

   What are some benefits of belonging to professional organizations?

   a) Up-to-date information
   b) Group insurance programs
   c) Business contacts
   d) Aid in funding research projects

5. Ask students why they purchase certain magazines such as Seventeen, Sports Illustrated, or TV Guide.

   Why is it important to subscribe to trade publications?

   a) Information about job openings
   b) Information about courses, seminars, or trips
   c) Information about new equipment to update a business
   d) Information about current research

F. Other activities

1. Ask someone from the landscape and/or turfgrass industry to be a guest speaker and share information about this field.

2. Have students read an article from a trade publication and list the information it provides.

3. Invite someone from a horticultural, professional organization to come in and speak about the organization.

G. Conclusion

There are many types of landscape and turfgrass industry jobs. Some industries will hire employees right out of high school while others require a two-to-four year college education. Once employed, it is good to become a member of a professional organization as well as subscribe to trade publication.

H. Competency

Identify and describe landscape and turfgrass jobs.

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I. Answers to Evaluation

1. a
2. d

3. Answers should contain four of the following: tell friends and relatives, tell horticulture teacher, look in the classified section of newspaper, look in yellow pages for businesses, check with employment agencies, check with school guidance and placement services, place ad in newspaper.

4. Answers should contain four of the following: mowing grass, raking leaves, snow plowing, being employed by business, repairing equipment, "lawnsitting."

UNIT I - EVALUATING OPPORTUNITIES IN THE LANDSCAPE AND TURFGRASS INDUSTRIES

Name ____________________

Date ____________________

Lesson 2: Careers and Professional Organizations in the Landscape and Turfgrass Industries

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which qualifies as an entry-level job requiring high school/vocational training?

   a) Garden center employee
   b) Landscape architect
   c) Horticulture teacher
   d) Plant breeder

2. Which is not a benefit of belonging to a professional organization?

   a) Possible provisions of group insurance programs
   b) Up-to-date information in their field
   c) Opportunities to meet new business contacts
   d) Reduced tuition at universities

Complete the following short answer questions.

3. What are four possible ideas that might help in looking for a job?

   a.
   b.
   c.
   d.

4. What are four possible SAEP's for landscape and turfgrass?

   a.
   b.
   c.
   d.

UNIT II - HOW PLANTS GROW

Lesson 1: Plant Growth and Development

Objective: The student will be able to demonstrate knowledge of the difference between monocot and dicot plants and how they differ in growth patterns.

Study Questions

1. **How does the structure of monocot and dicot plants differ?**
2. **How do monocot and dicot plants grow in diameter?**
3. **How does the location of the meristems in monocot and dicot plants determine the growing points?**

References

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
2. Work Sheet
    a) WS 1.1: Monocot and Dicot Plant Structure

Lesson 1: Plant Growth and Development

TEACHING PROCEDURES

A. Introduction

It is important to know basic differences in plant growth in order to be successful in selecting, installing, and maintaining plants in a landscape. Knowing how the growth patterns of monocot and dicot plants differ, helps a landscaper use each plant for a unique purpose. Review curriculum in Plant Science I or Greenhouse Operation and Management Curriculum (photosynthesis, respiration, and transpiration processes).

B. Motivation

Knowing how a plant grows, its parts, structure, and functions help us to understand the purpose of each plant in the environment.

C. Assignment

D. Supervised study

E. Discussion

1. Ask the students to give some examples of monocot and dicot plants. Ask them to tell how the plants look different.

   How does the structure of monocot and dicot plants differ?

   a) Monocots
      1) External structure
         (a) One cotyledon leaf
         (b) Narrow leaves with parallel venation
         (c) Flower petals in threes or sets of three
      2) Internal structure
         (a) Vascular bundles scattered randomly throughout stem
         (b) No vascular cambium
   b) Dicots
      1) External structure
         (a) Two cotyledon leaves
         (b) Leaves vary in shape and have netted venation
         (c) Flower petals in groups of four or five
      2) Internal structure
         (a) Vascular bundles arranged in cylindrical form
         (b) Vascular cambium

2. Ask the students to explain how plants get larger in diameter.

   How do monocot and dicot plants grow in diameter?

   a) Monocot - grow in diameter by expansion of existing cells
   b) Dicots - grow in diameter by cell division in cambium layer

3. Ask the students to locate the points at which plants grow.

   How does the location of the meristems in monocot and dicot plants determine the growing points?

   a) Monocot meristems
      1) Located in tips of roots
      2) Located in intercalary meristem above node
      3) Cause growth in height
   b) Dicot meristems
      1) Located in tips of roots
      2) Located in tips of stems
      3) Cause growth in height

F. Other activities

1. Practice labeling schematic diagrams and cross sections of plants, internal stem structures, growing points, and meristem tissues.

2. Bring in different monocot and dicot plants. Allow students to observe vascular systems in a cross-sectional cut.

3. Sow a monocot seed (corn) and a dicot seed (bean). Note that monocot seeds have one cotyledon while dicot seeds have two cotyledons.

G. Conclusion

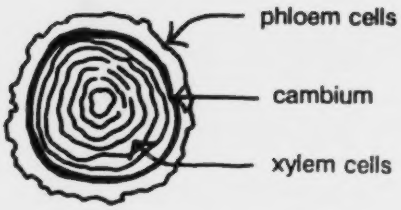
The major differences between monocot and dicot plants are that dicot plants have a vascular cambium, netted venation, and cylindrically arranged vascular bundles. Dicot plants grow in height at the apical meristem and in width at the vascular cambium. Monocot plants have no vascular cambium, parallel venation, and scattered vascular bundles. Monocot plants grow in height at the intercalary meristem and in width by expansion of cells. It is essential to know these basic differences in plant growth before one can be successful in selecting, installing, and maintaining landscape plants.

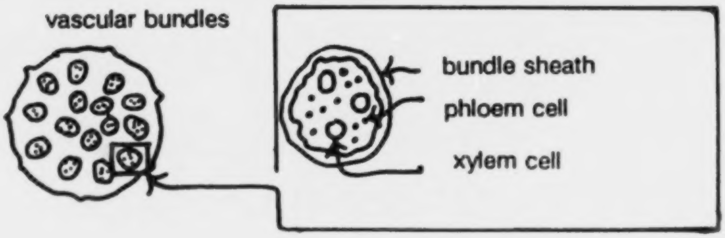
H. Competency

Label plant parts and structures correctly and identify the differing growth patterns of monocot and dicot plants.

I. Answers to Evaluation

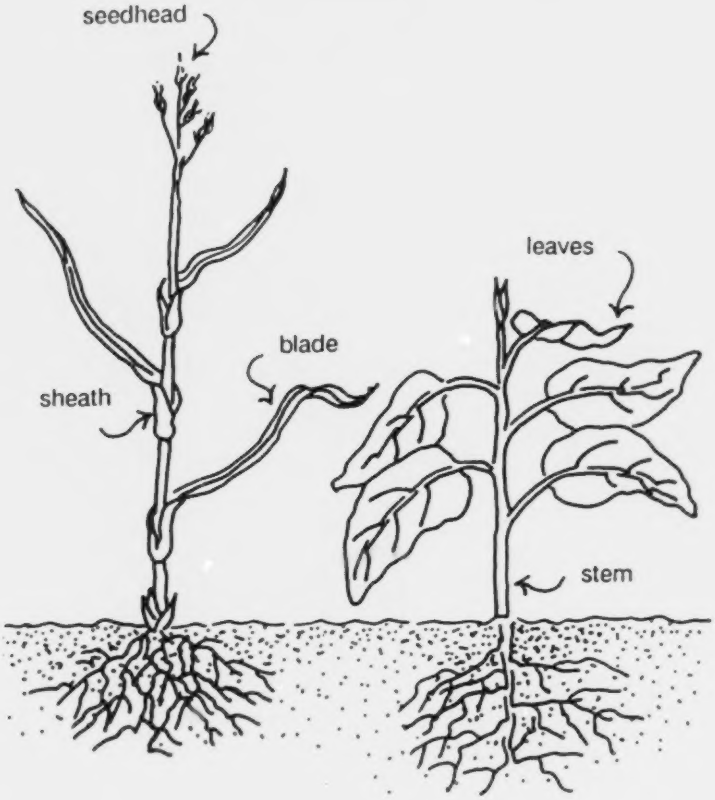
1. c
2. d
3. b
4. d
5. d
6. a
7. a
8. c


phloem cells
cambium
xylem cells


vascular bundles
bundle sheath
phloem cell
xylem cell

9. Monocot: phloem - carries food to roots
xylem - carries water upward
Dicot: phloem - carries food to roots
xylem - carries water upward
cambium - separates phloem and xylem and area of new cell division

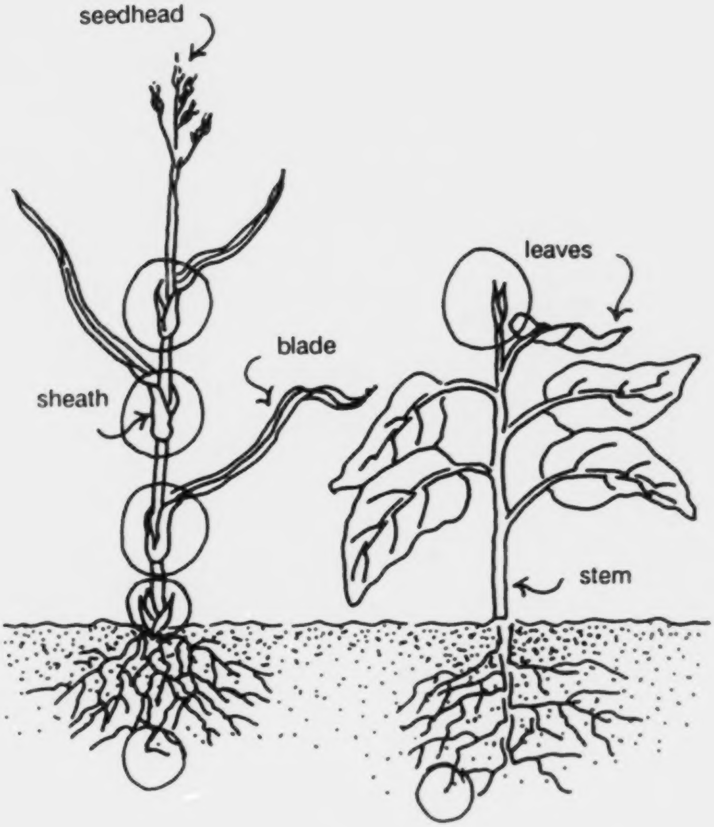
10.


seedhead
sheath
blade
leaves
stem

MONOCOT DICOT

J. Answers to work sheet

Work Sheet 1.1 - Monocot and Dicot Plant Structure


seedhead
leaves
blade
sheath
stem

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UNIT II - HOW PLANTS GROW

Name ____________________

Lesson 1: Plant Growth and Development

Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. What are the external characteristics of a monocot plant?

   a. Netted venation, two cotyledons, and flower petals in sets of three
   b. Parallel venation, one cotyledon, and flower petals in sets of four or five
   c. Parallel venation, one cotyledon, and flower petals in threes or sets of three
   d. Parallel venation, two cotyledons, and flower petals in threes or sets of three

2. What are included in the internal characteristics of monocot plants?

   a. Scattered vascular bundles, vascular cambium, phloem and xylem
   b. Cylindrical arrangement of vascular bundles, cambium, phloem, and xylem
   c. Scattered vascular bundles, phloem, xylem, and internodes
   d. Scattered vascular bundles, phloem, xylem, and bundle sheath

3. What is the growing point on a monocot plant that causes growth in height?

   a. Terminal bud
   b. Intercalary meristem above the node at the lower part of the plant
   c. Tip of the blade
   d. Axillary bud

4. How does a monocot plant grow in diameter?

   a. By cell division in the cambium layer
   b. By the apical meristem
   c. By the intercalary meristem
   d. By expansion of existing cells

5. What do dicot plants have that cause them to differ from monocot plants?

   a. Netted venation
   b. Scattered vascular bundles
   c. Vascular cambium
   d. a. and c.

6. What are included in the internal structure of dicot plants?

   a. Cylindrical arrangement of vascular bundles, vascular cambium, xylem, and phloem
   b. Scattered vascular bundles, phloem, xylem, and bundle sheath
   c. Axillary bud, cylindrical arrangement of vascular bundle, and vascular cambium
   d. Scattered vascular bundles, phloem, xylem, and internodes

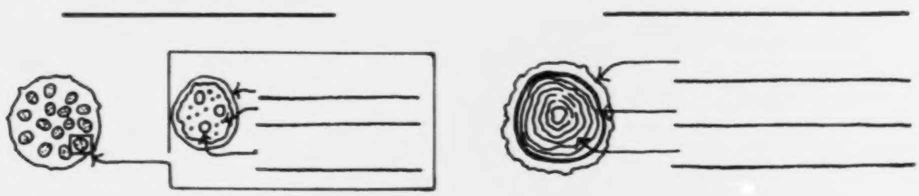
7. At what part do dicot plants grow in height?

   a. Apical meristem
   b. Intercalary meristem
   c. Internode
   d. Root cup

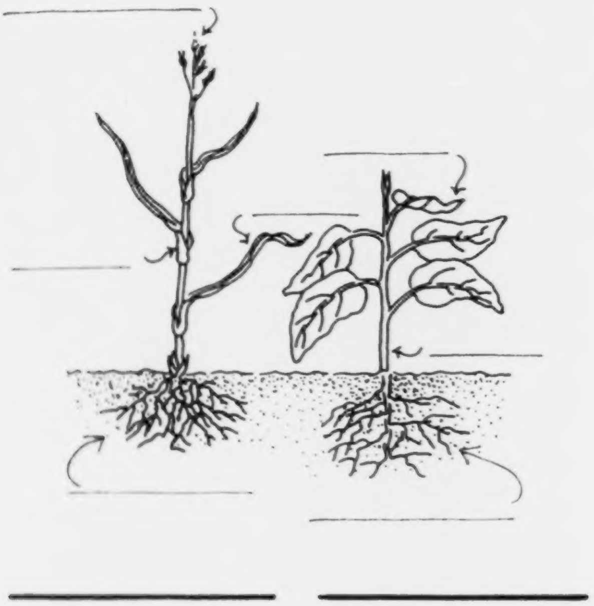
8. Where does growth in diameter take place in dicot plants?

   a. In the apical meristem
   b. By expansion of existing cells
   c. By cell division in the cambium layer
   d. In the intercalary meristem

9. In these cross-sectional diagrams, which is a monocot and which is a dicot? Label the internal structures of each stem cross section.



10. Identify which plant is a monocot and which is a dicot. Label the indicated parts.



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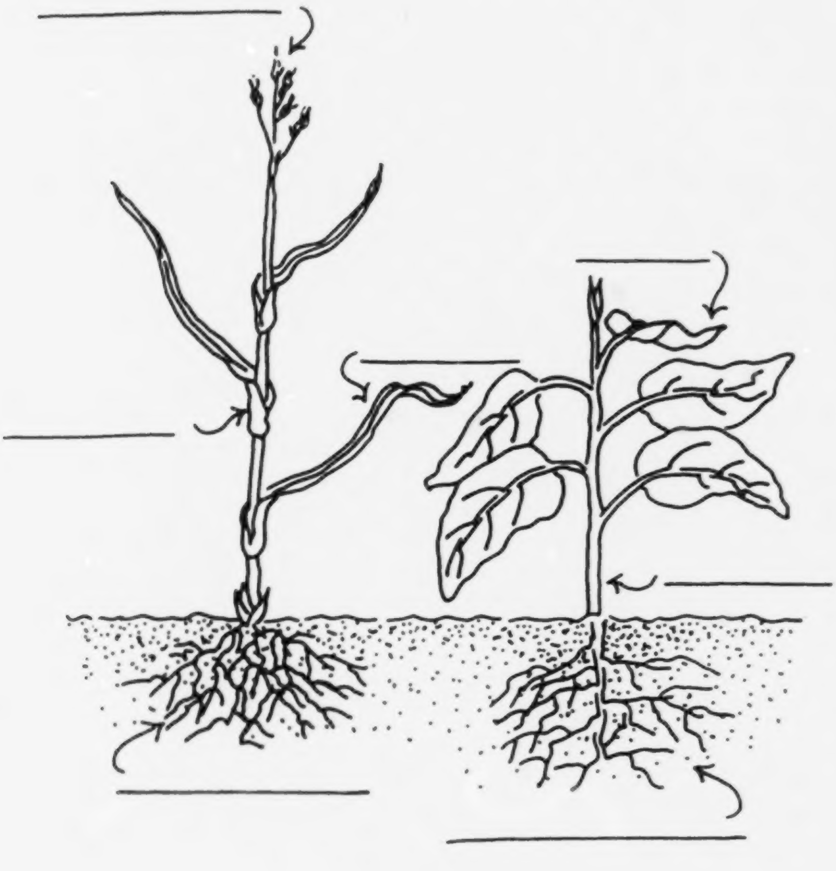
UNIT II - HOW PLANTS GROW

Lesson 1: Plant Growth and Development

Work Sheet 1.1: Monocot and Dicot Plant Structures

Label the following diagrams. Circle the areas where the apical and intercalary meristems are located.



UNIT II - HOW PLANTS GROW

Lesson 2: Environmental Factors Below Ground that Affect Plant Growth

Objective: The student will be able to demonstrate knowledge of the soil factors affecting plant growth, and how to improve the soil.

Study Questions

1. **What are the components of soil and how are they formed?**
2. **What are the six environmental factors below ground that affect plant growth?**
3. **How do soil structure and texture affect plant growth?**
4. **How does the balance between air and water in the soil affect plant growth?**
5. **How does soil fertility and pH affect plant growth?**
6. **How can soil be improved?**

References

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
2. Transparency Masters
    a) TM 2.1: Textural Triangle
    b) TM 2.2: Nutrient Availability
3. "Soil Samples" from the Instructional Materials Laboratory, University of Missouri-Columbia, 10 London Hall, Columbia, MO 65211.
4. University Extension guides
    a) Submitting a Soil Sample, #9109
    b) Sampling Your Soil for Testing, #9110
    c) Using Your Soil Test Results, #9111
5. Work Sheets
    a) WS 2.1: Using the Textural Triangle
    b) WS 2.2: Solving pH Problems

UNIT II - HOW PLANTS GROW

Lesson 2: Environmental Factors Below Ground That Affect Plant Growth

TEACHING PROCEDURES

A. Review

Review previous lesson.

B. Motivation

The components of soil as well as the effects of environmental factors on soil are important to successful plant growth. Therefore, a landscaper needs to understand these factors, as well as how to improve soil when necessary.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students to think of things a plant needs from the environment in order to grow. Soil is the most commonly overlooked factor. Point out the importance of soil to plant growth.

What are the components of soil and how are they formed?

a) Soil Profile
   1) Bedrock
   2) Subsoil
   3) Topsoil
b) Components of an Ideal Soil
   1) 45% particle matter
   2) 5% organic matter
   3) 25% water
   4) 25% air
   5) Microorganisms
c) Weathering - breaks down bedrock
   1) Wind
   2) Freezing and thawing
   3) Water movement
   4) Roots
   5) Microbe activity
d) Soil movement
   1) Alluvial soils - by water
   2) Glacial till - pushed by glaciers
   3) Loess - blown by the wind

2. Ask the students for the six underground factors that determine how plants grow.

What are the six environmental factors below ground that affect plant growth?

a) Texture

b) Structure
c) Air
d) Water
e) Fertility
f) pH

3. Ask the students to define texture and structure. Write their definitions on the board. Consider showing the filmstrip, "Soil Texture" and/or "Soil is Soil...Isn't It?" Hand out UMC Guides, #9109, #9110, and #9111. Use TM 2.1.

How do soil structure and texture affect plant growth?

a) Texture - size and distribution of particles
    1) Soil name
        (a) Textural triangle - particle percentages determines name
        (b) Loam soils - best for landscaping use
    2) Sand - largest
        (a) Best drainage
        (b) Low water holding
        (c) Much air space - porosity
        (d) No nutrient benefit
    3) Silt - middle
        (a) Drains fairly well
        (b) Some water holding
        (c) Some air space
        (d) Some nutrient benefit
    4) Clay - smallest
        (a) Does not drain well
        (b) High water holding (sometimes too much)
        (c) Very little air space
        (d) Offers many nutrients
b) Structure - arrangement of soil particles (aggregates)
    1) Kinds of aggregates
        (a) Granular - best for horticultural use, many air spaces
        (b) Plate
        (c) Block
        (d) Prismatic
    2) Improved by adding organic matter
    3) Tilth destroyed by
        (a) Compaction
        (b) Digging soil when too wet
c) Texture and structure provide pores for
    1) Air
    2) Water
    3) Roots
d) Soil color
    1) Dark
    2) Uniformly colored
    3) Yellowish or reddish
    4) Whitish
    5) Bluish or grayish
e) Soil depth

4. Ask two students to try to stand in the same spot. Stress that no two objects can occupy the same space at the same time, nor can air and water occupy the same space in the soil.

How does the balance between air and water in the soil affect plant growth?

a) Air and water balance
   1) 25% of each
   3) As one increases the other decreases
   4) Excess of either air or water causes problems
b) Pore spaces
   1) Determined by texture and structure
   2) Larger in sand for drainage and aeration
   3) Smaller in clay, which retains water
c) Water movement
   1) Determined by the size and quantity of pore spaces
   2) Types
      (a) Non-capillary - gravitational water
      (b) Capillarity - capillary water
      (c) Hygroscopic water
   3) Available water - between field capacity and permanent wilting point
   4) Perched water table - layering of soil textures

5. Ask for student ideas about fertility and pH. (Use TM 2.2.)

How does fertility and pH affect plant growth?

a) Fertility - ability of soil surface particles to absorb nutrients
   1) Forms of nutrients
      (a) Weathered rock minerals
      (b) Organic matter
      (c) Fertilizer
   2) Must be in soil solution to be available to plant roots
   3) Held by clay and organic matter
   4) CEC (Cation Exchange Capacity)
      (a) Ability to attract and exchange cations
      (b) Higher CEC in soil higher in organic matter or clay
   5) Soil test for soluble salts
      (a) Range - 0.1-3.5
      (b) Best - 1.0-1.5
      (c) Nutrient deficiency - growth stunting and starvation
      (d) Toxic - wilting and nutrient deficiency symptoms
b) Soil reaction - pH
   1) pH scale
      (a) Acidic - 4.0
      (b) Alkaline - 14.0
      (c) Neutral - 7.0
      (d) Sour soils, 0-7
      (e) Sweet soils, 7-14
   2) pH too high or too low
      (a) Ties up some nutrients
      (b) Makes others toxic
   3) Adjusting pH
      (a) Too acidic - add lime to raise pH
      (b) Too alkaline - add sulphur to lower pH

6. Ask the students if they know what they can do the improve poor soils.

   How can the soil be improved?

   a) Adding organic matter improves soil.
      1) Texture
      2) Structure
      3) Fertility
      4) Permeability
   b) Tilling improves the soil's ability to hold water and air.

F. Other activities

1. Demonstrate how to use the textural triangle.

2. Demonstrate how to take a soil sample.

3. Have students practice finding the names of different soils.

4. Have students take a soil sample. The soil sample taken for this unit for testing should be from a school site that can be used for planting landscape plants (trees, shrubs, or annuals). Preparing and planting the site will be done in future activities. Prepare the soil sample to send to the County Extension Agent for testing. If testing equipment is available at your school, test the pH and soluble salt levels.

5. Demonstrate the movement of water by using a sponge.

6. Use the sponge to demonstrate a perched water table.

7. Demonstrate a perched water table by placing a fine-textured soil over a coarse-textured soil in a small glass box. Pour water into the top. Watch as the water fills the entire layer of fine-textured soil before it enters into the coarse-textured soil (or gravel).

8. In cooperation with a local nursery, visit a planting site. Ask the landscaper what is done to evaluate the soil and to improve the soil, if needed.

G. Conclusion

The textural and structural condition of the soil, the air and water movement, and the pH and fertility of the soil are all essential to healthy plants. If any of these factors are found to be deficient, they must be improved. Adding organic matter will help the texture, structure, air and water movement, and fertility. Adding fertilizer will also help the fertility. Adding lime or sulphur will alter the pH.

H. Competency

Demonstrate knowledge of soil properties and how soil quality relates to plant growth; assess the soil at a planting site and determine how to improve it, if needed.

I. Answers to Evaluation

1. j
2. k
3. a
4. b
5. m
6. n
7. g
8. c
9. d
10. e
11. f
12. l
13. o
14. h
15. i
16. a. Freezing and thawing
    b. Wind
    c. Plant roots
    d. Microbial activity
    Alternate: water movement
17. a. Particle matter - 45%
    b. Organic matter - 5%
    c. Air - 25%
    d. Water - 25%
18. a
19. d
20. b
21. a
22. d
23. b
24. b
25. a
26. c
27. b
28. c

J. Answers to work sheets

Work Sheet 2.1 - Using the Textural Triangle

1. Clay
2. Silt Loam
3. Loam
4. Clay
5. Loam
6. Clay loam
7. Clay loam
8. Sandy clay
9. Sandy loam
10. Sandy clay loam

Work Sheet 2.2 - Solving pH problems

1. Sulphur, aluminum sulphate
2. Agricultural lime, lime
3. Agricultural lime, lime
4. Sulphur, aluminum sulphate
5. 7.0
6. 0 to 7
7. 7 to 14

UNIT II - HOW PLANTS GROW

Name ________________

Lesson 2: Environmental Factors Below Ground That Affect Plant Growth

Date ________________

EVALUATION

Match the word on the right with the definition on the left.

1. _____ soils transported by glaciers
2. _____ plant and animal residue and remains
3. _____ largest component of soil
4. _____ soils transported by water
5. _____ size distribution of soil particles (sand, silt, clay)
6. _____ soils transported by wind
7. _____ arrangement of soil particles
8. _____ soil reaction
9. _____ water held by soil that is unavailable for plant use
10. _____ water held by capillarity available for plant use
11. _____ physical condition of the soil
12. _____ state of the soil when it holds the maximum amount of water without runoff
13. _____ state at which soil moisture is unavailable to plants
14. _____ water that runs freely from the soil
15. _____ ability of the soil to exchange ions

a. particle matter
b. alluvial soils
c. pH
d. hygroscopic water
e. capillary water
f. tilth
g. structure
h. gravitational water
i. CEC
j. glacial till
k. organic matter
l. field capacity
m. texture
n. Loess soils
o. permanent wilting point

Complete the following short answer questions.

16. What are four ways that soils are weathered?

a.
b.
c.
d.

17. What are the four components and their percentages in an ideal soil?

a.
b.
c.
d.

Circle the letter that corresponds to the best answer.

18. What is located in pore spaces between particles of soil?

a. Air or water
b. Organic matter
c. Fertilizer
d. pH

19. A silt loam soil has what percentages of sand, silt, and clay?

a. 60% sand, 30% silt, and 10% clay
b. 25% sand, 30% silt, and 45% clay
c. 80% sand, 10% silt, and 10% clay
d. 25% sand, 55% silt, and 20% clay

20. What benefit does soil provide for plant growth?

a. Organic matter, pH, and water
b. Water, nutrients, and root anchorage
c. Water, bedrock, and root anchorage
d. Texture, structure, and nutrients

21. What does the bedrock, subsoil, and topsoil make up?

a. Soil profile
b. Particle matter
c. Texture and structure
d. Tilth

22. After evaluating a site on which a tree will be planted, it is concluded that the soil remains wet for a long period of time, water drains slowly after a rain, and the fertility is good. What kind of soil is it?

a. Silty
b. Sandy
c. Structured
d. Clay

23. In evaluating soil at another site, it is concluded that it holds very little water, drains quickly after a rain, and has very poor fertility. What kind of soil is it?

a. Silty
b. Sandy
c. Structured
d. Clay

24. A heavy, clay soil with poor texture and structure has limited porosity. Why does a plant in this soil grow poorly?

a. The pH is too low
b. There is an improper balance of air and water
c. There is a nutrient deficiency
d. The pH is too high

25. An azalea that has been planted requires an acidic soil, but a soil test determined that the soil is alkaline. What can be added to improve the soil?

a. Aluminum sulphate
b. Agricultural lime
c. Fertilizer
d. Organic matter

26. What type of soil has a pH of 6.5?

a. Neutral
b. Alkaline
c. Acidic
d. "Sweet"

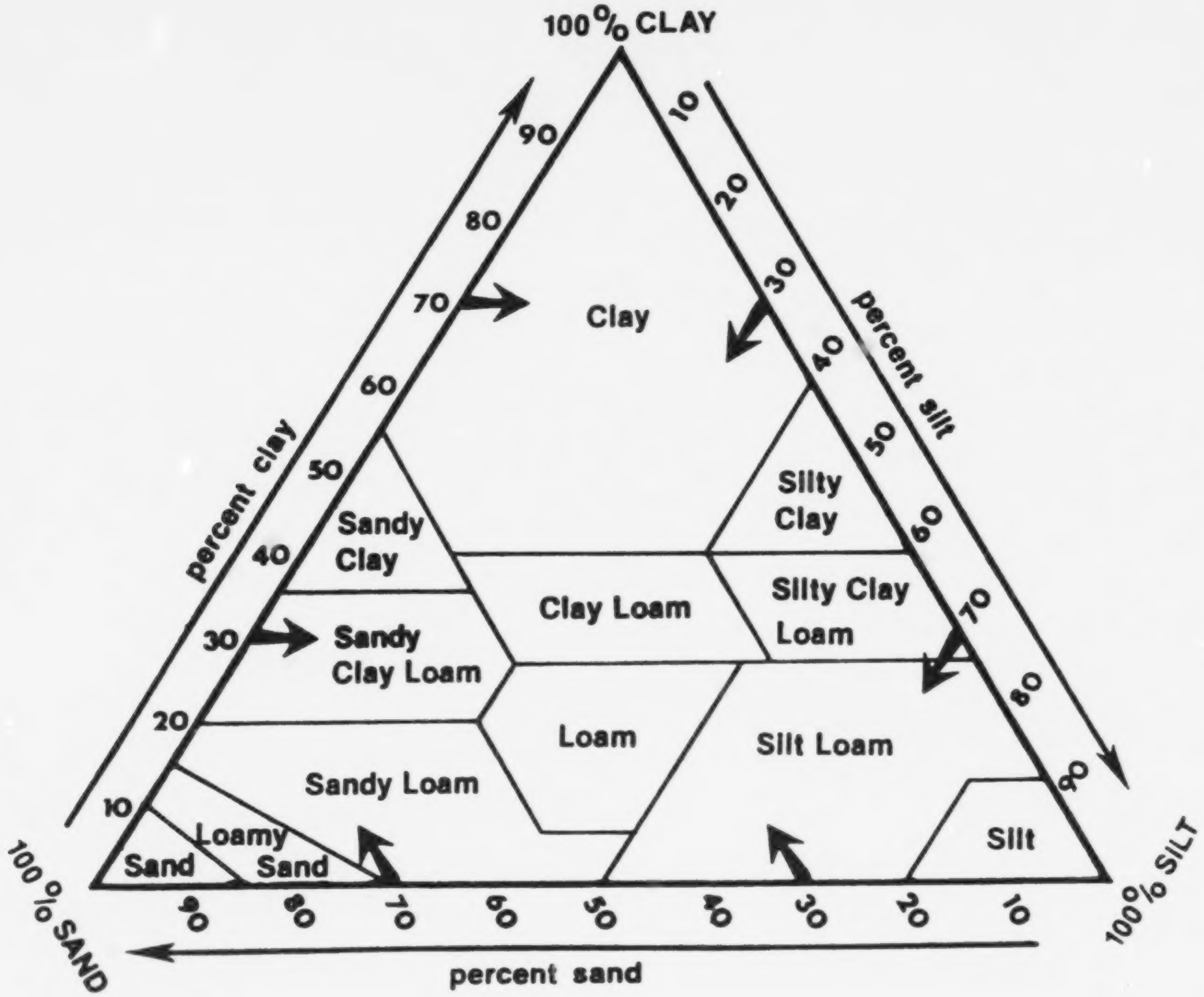
27. What type of soil has a pH of 8.5?

a. Neutral
b. Alkaline
c. Acidic
d. "Sour"

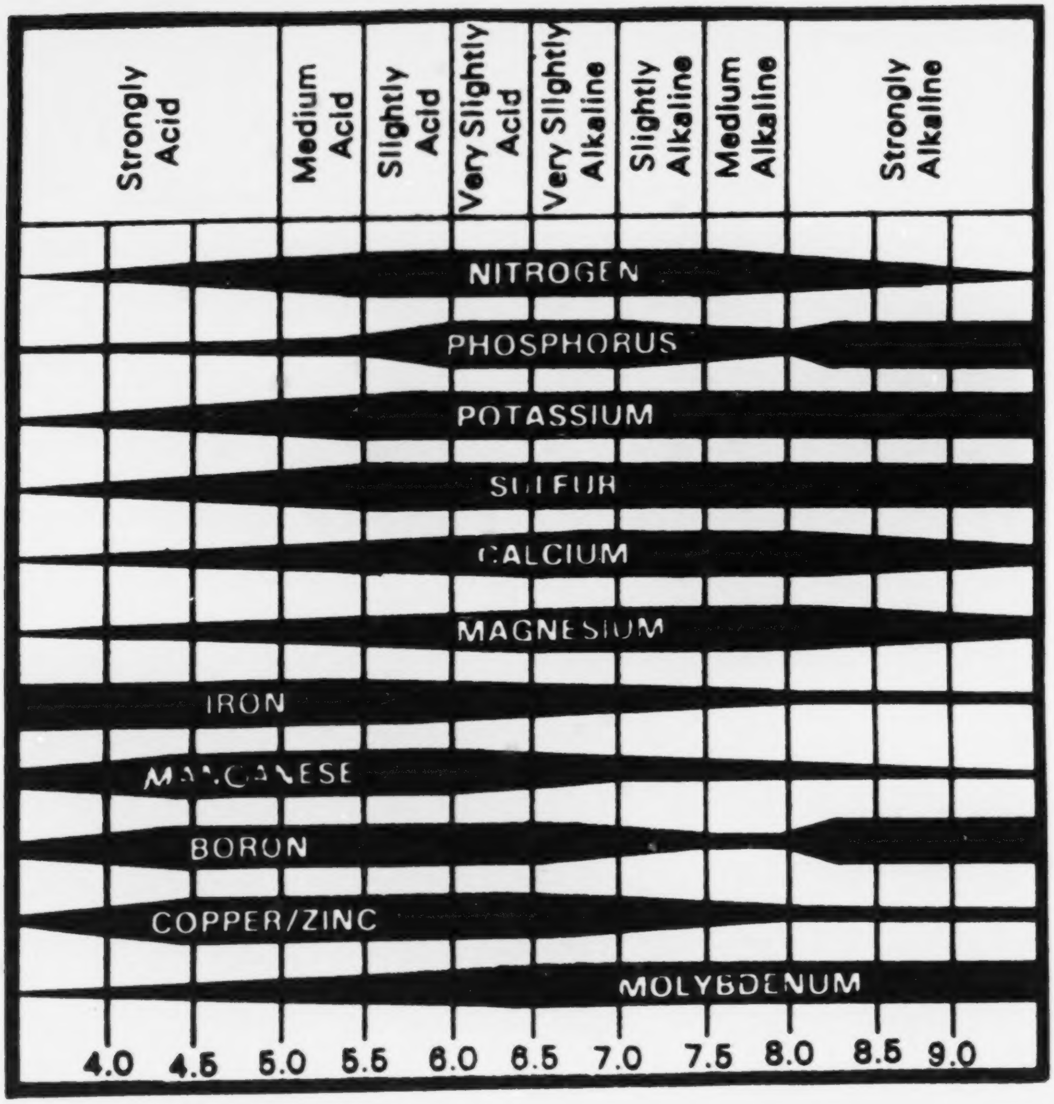
28. What can be added to soil to improve the texture, structure, fertility, and permeability of the soil?

a. Water
b. Particle matter
c. Organic matter
d. Agricultural lime

Textural Triangle


100% CLAY
100% SAND
100% SILT
percent clay
percent silt
percent sand
10
20
30
40
50
60
70
80
90
Clay
Sandy Clay
Silty Clay
Clay Loam
Silty Clay Loam
Sandy Clay Loam
Loam
Silt Loam
Sandy Loam
Silt
Loamy Sand
Sand

Nutrient Availability



Soil pH Governs Nutrient Release

Acidity or alkalinity (pH) controls relative nutrient availability.

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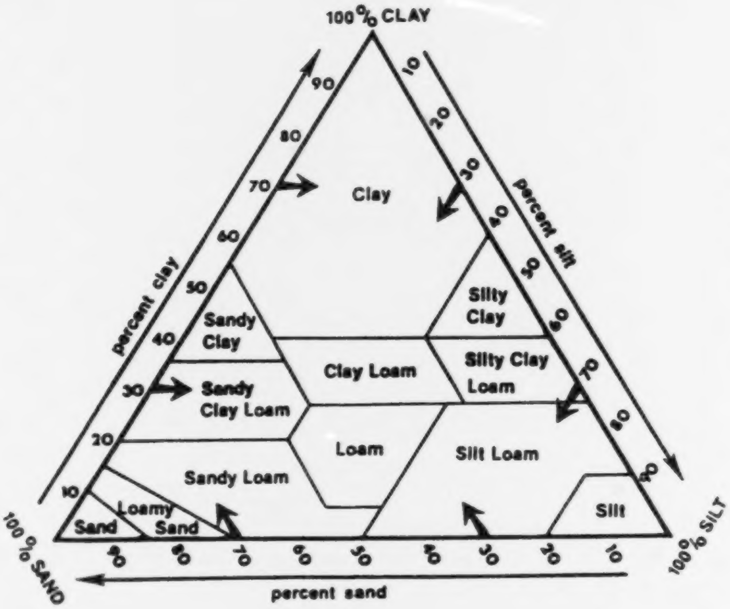
Lesson 2: Environmental Factors Below Ground that Affect Plant Growth

Work Sheet 2.1: Using the Textural Triangle

Using the textural triangle, plat the percentages on the following page. Follow the procedure of the example given below.


100% CLAY
percent clay
percent silt
percent sand
100% SAND
100% SILT
90
80
70
60
50
40
30
20
10
Clay
Sandy Clay
Silty Clay
Clay Loam
Silty Clay Loam
Sandy Clay Loam
Loam
Silt Loam
Sandy Loam
Loamy Sand
Sand
Silt

Example: 35% clay, 45% silt, and 20% sand

a) Plot the silt and clay points on the triangle.
b) Using the clay point, draw a line into the triangle parallel to the sand line (line a).
c) Using the silt point, draw a line parallel to the clay line (line b).
d) The point where these two lines intersect determines the soil type; in this example, it is silty clay loam.

	% CLAY	% SILT	% SAND	SOIL TYPE
1.	60	30	10	
2.	25	55	20	
3.	25	30	45	
4.	80	10	10	
5.	20	35	45	
6.	30	40	30	
7.	30	45	25	
8.	40	10	50	
9.	10	30	60	
10.	30	25	45	

Lesson 2: Environmental Factors Below Ground that Affect Plant Growth

Work Sheet 2.2: Solving pH Problems

An improper pH can damage or kill a plant. In case of a situation with too low or too high a pH, one must know what to do to remedy it. Answer the following questions, which provide practice for solving pH problems.

1. A soil has a pH of 9.8. A pH of 7.0 is needed. What could be added to correct the problem?

   ____

2. A soil has a pH of 4.5. A pH of 6.9 is needed. What could be added to correct the problem?

   ____

3. A soil is too acidic. What could be added to correct the problem?

   ____

4. A soil is too alkaline. What could be added to correct the problem?

   ____

5. A soil is neutral. What is the pH? ____________________
6. A soil is sour. What is the pH range? ____________________ to ____________________
7. A soil is sweet. What is the pH range? ____________________ to ____________________

UNIT II - HOW PLANTS GROW

Lesson 3: Environmental Factors Above Ground that Affect Plant Growth

Objective: The student will be able to describe environmental factors that affect plants.

Study Questions

1. **What are the three climatic types and the factors which influence them?**
2. **How does temperature determine the plants that can be grown in the landscape?**
3. **How does light affect plant growth?**
4. **How do water and humidity affect plant growth?**
5. **How do wind and air quality affect plant growth?**

References

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
2. Work Sheet
    a) WS 3.1: Factors Above Ground That Affect Plant Growth

UNIT II - HOW PLANTS GROW

Lesson 3: Environmental Factors Below Ground that Affect Plant Growth

TEACHING PROCEDURES

A. Review

Review previous lesson.

B. Motivation

Landscapers may not be able to change factors of climate and weather, but they can understand them in order to use these factors to their advantage.

C. Assignment

D. Supervised study

E. Discussion

1. Ask the students to give examples of macroclimates, mesoclimates, and microclimates. Ask them what factors determine climate (light intensity, precipitation, temperature, humidity, air, and wind). This can be related to the school, with the campus representing the macroclimate, the classroom representing the mesoclimate, and an area in the classroom representing a microclimate. For example, a window ledge would be warmer and drier than a dark, secluded corner on the opposite side of the room.

What are the three climatic types and the factors which influence them?

a) Macroclimate influenced by
    1) Mountains
    2) Oceans
    3) Elevation
    4) Seasons
    5) Forests
    6) Air masses
b) Mesoclimate influenced by
    1) Buildings
    2) Lakes
    3) Topography
c) Microclimate influenced by
    1) House
    2) Slopes and hills
    3) Trees

2. Ask the students if they know the plant hardiness zone they live in. Have them check the map if they do not know. Explain that plants are adapted to different locations. For example, house plants that come from tropical areas must be brought inside during the winter in the Midwest because they will not survive the cold temperatures. Landscapers must know the hardiness zone of their locations and hardiness zone listing of plants.

How does temperature determine the plants that can be grown in the landscape?

a) Temperature affects
  1) Photosynthesis
  2) Transpiration
  3) Respiration
b) High temperature
  1) Increased transpiration
  2) More pests and disease
c) Hardiness Zone Map
d) Low temperature
  1) Freeze damage
  2) Spring frost damage
  3) Moisture deficiency
  4) Heaving
e) Warm-season, cool-season, and rest period crops

3. Ask the students why chrysanthemums only bloom in the fall. Point out that they need short days to bloom and will not bloom in the long days of summer. This is photoperiodism.

How does light affect plant growth?

a) Color or wavelength
b) Intensity
  1) Effects on
    (a) Height
    (b) Internode length
    (c) Color
  2) Effects of light intensity
c) Responses to light
  1) Phototropism
  2) Photoperiodism
    (a) Long-day plants
    (b) Short-day plants
    (c) Day-neutral plants

4. Ask the students about the importance of water to plants. Ask the students if too much water can be damaging to plants, and if they know what relative humidity is.

How do water and humidity affect plant growth?

a) Water status
  1) Turgid
  2) Wilted
  3) Temporarily wilted
b) Water deficiency
  1) Effects
    (a) Gray-green color on leaves
    (b) Leaves rolled at the edges
    (c) Wilted
    (d) Fruit and vegetable damage
    (e) Buds drop
b) Effects of water excess
  1) Yellowed
  2) Wilted
  3) Diseased, damping off

    - 4) Split fruits
  - c) Humidity and its effects
    - 1) Definition of relative humidity
    - 2) High humidity - increasing disease
    - 4) Low humidity - damaging with a strong wind

5. There is much pollution in cities. The forests still standing help to remedy this problem, but they are located away from the pollution sources in cities. If every city dweller would plant a pollution-tolerant tree, in the city where pollution exists, air quality may be improved.

   How do wind and air quality affect plant growth?

   - a) Wind
     - 1) Increases transpiration
     - 2) Causes plant breakage
     - 3) Increases CO_2 which increases photosynthetic absorption
   - b) Air pollution
     - 1) Effects
       - (a) Clogged stomata
       - (b) Covers leaf surfaces
     - 2) Sources
       - (a) Sulphur dioxide
       - (b) Fluoride
       - (c) Ozone
       - (d) PAN (peroxyacetyl nitrates)
     - 3) Symptoms
       - (a) Broad leaf plants
         - (1) Dead spots
         - (2) Dead tips and edges
         - (3) Silver leaf undersides
       - (b) Needle evergreen plants
         - (1) Dead spots
         - (2) Yellow cast
     - 4) Solutions
       - (a) Plant pollution-tolerant plants
       - (b) Rinse leaves
       - (c) Use fungicides
       - (d) Use growth retardants

F. Other activity

To demonstrate phototropism, plant a bean seed or use a house plant, if available, and place it in front of a window. Leave it facing the same direction for three to five days. Point out to students that the plant leaves grow or bend toward the area of greatest light intensity.

G. Conclusion

In order to get a plant to grow successfully in a landscape, average temperatures, light intensity, precipitation, relative humidity, and air quality must be determined for the area. Plants that will grow in those conditions may then be selected.

H. Competency

Describe environmental factors that affect plants.

I. Answers to Evaluation

1. f
2. d
3. a
4. c
5. e
6. j
7. b
8. i
9. h
10. k
11. g
12. Gray-green colored leaves, leaves with rolled edges, wilting, and buds drop (alternate - fruit and vegetable damage)
13. Yellow leaves, wilting, root diseases
14. Sulphur dioxide, fluorine, PAN, ozone
15. a
16. a
17. a
18. b
19. b
20. c
21. d
22. d
23. c

J. Answers to work sheet

Work Sheet 3.1 - Factors Above Ground That Affect Plant Growth

At the teacher's discretion

UNIT - HOW PLANTS GROW

Lesson 3: Environment Factors Above Ground that Affect Plant Growth

Name ____________________

Date ____________________

EVALUATION

Match the word on the right with the definition on the left.

1. ____ Climate on a smaller scale influenced by lakes, buildings, and topography
2. ____ A plant that will grow best in a temperature between 75°-90°F
3. ____ Phase in which the plant does not grow even though environmental conditions are favorable
4. ____ Climate on a very small scale that may be influenced by a house, slopes, hills, and awnings
5. ____ Phase in which the plant does not grow because environmental conditions are not favorable
6. ____ Climate in a large area; such as Alaska; influenced by oceans, mountains, air masses, forests, and elevation
7. ____ Plant response that causes a plant to grow in the direction of greatest light intensity
8. ____ Plant that will grow best in temperatures between 60°-80°
9. ____ Amount of moisture in the air as compared with the percentage of moisture that the air could hold at that same temperature if the air were completely saturated
10. ____ Level of moisture in the air
11. ____ Plant response that causes plants to bloom only on days that are a particular length

a. Rest period
b. Phototropism
c. Microclimate
d. Warm-season plant
e. Dormancy
f. Mesoclimate
g. Photoperiodism
h. Relative humidity
i. Cool-season plant
j. Macroclimate
k. Humidity

Complete the following short answer questions.

12. What are four symptoms of plants that have suffered from moisture deficiency?

a.
b.
c.
d.

13. What are three symptoms of plants that have suffered from excess moisture?

a.
b.
c.

14. What are four chemical air pollutants that cause damage to plants?

a.
b.
c.
d.

Circle the letter that corresponds to the best answer.

15. A plant will usually grow in a ________________ hardiness zone than listed but not a ________________ hardiness zone.

a. Warmer, colder
b. Colder, warmer
c. Warmer, wetter
d. Colder, wetter

16. Which is not a plant process that is affected by high temperature?

a. Light quality
b. Photosynthesis
c. Respiration
d. Transpiration

17. What results when a plant does not receive enough light?

a. Pale leaves and spindly growth
b. Pale leaves and compact growth
c. A red color
d. "Burned" leaves

18. What effect does wind have on temperature?

a. Heaving
b. Lowering
c. Moving
d. Raising

19. What are plants that flower when the nights are shorter than a critical length?

a. Day-neutral plants
b. Long-day plants
c. Long-night plants
d. Short-day plants

20. What are plants that flower when the nights are longer than a critical length?

    a. Day-neutral plants
    b. Long-day plants
    c. Short-day plants
    d. Short-night plants

21. What causes the sunflower to follow the sun as it moves from east to west across the sky?

    a. Photogenic
    b. Photoperiodism
    c. Photosynthesis
    d. Phototropism

22. How does air pollution damage plants?

    a. By clogging the stomata
    b. By slowing photosynthesis
    c. By slowing transpiration
    d. a. and b.

23. What should a landscaper do in areas of high air pollution?

    a. Avoid planting trees
    b. Wash down the trees weekly
    c. Plant air-pollution-tolerant trees
    d. Treat the trees with chemicals

Lesson 3: Environmental Factors Above Ground that Affect Plant Growth

Work Sheet 3.1: Factors Above Ground That Affect Plant Growth

Define the following terms.

1. Macroclimate
2. Mesoclimate
3. Microclimate
4. Rest period
5. Dormancy
6. Freeze damage
7. Heaving
8. Cool-season plant
9. Warm-season plant
10. Phototropism
11. Photoperiodism
12. Short-day plant
13. Long-day plant
14. Humidity
15. Relative humidity

Explain how each of the following affects plants.

16. Water excess

17. Water deficiency

18. High light intensity

19. Low light intensity

20. Very high temperatures

21. Very low temperatures

22. Wind damage

23. Air pollution

24. Sulphur dioxide

25. Fluorine

26. PAN

27. Ozone

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UNIT III - IDENTIFICATION

Lesson 1: Identifying Characteristics of Trees and Shrubs

Objective: The student will be able to demonstrate a knowledge of the characteristics of plants which will aid plant identification.

Study Questions

1. **What are the differences between woody, herbaceous, and deciduous plants; broad-leaf and narrow-leaf evergreens; and shrubs?**
2. **What are the differences between vines and groundcovers?**
3. **What are the differences between annual and perennial plants?**
4. **What is form; and what are the typical natural tree and shrub forms?**
5. **What are the external parts of the stem; and the differences between the types of buds?**
6. **What are the leaf structures and arrangements that help in plant identification?**

Reference

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.

UNIT III - IDENTIFICATION

Lesson 1: Identifying Characteristics of Trees and Shrubs

TEACHING PROCEDURES

A. Introduction

Landscapers are able to do their work more efficiently when they can readily identify many types of plants. This unit will provide information on specific plant characteristics which aid in identification.

B. Motivation

In the landscaping business it is often necessary to identify plants upon sight, without the aid of guides. Knowing plant characteristics can help with identification.

C. Assignment

D. Supervised study

E. Discussion

1. Take the class outside and have them identify as many different types of plants as possible.

   What are the differences between woody, herbaceous, and deciduous plants; broad-leaf and narrow-leaf evergreens; and shrubs?

   a) Woody plants
      1) Outer bark covering
      2) Survive the winter (if hardy)
      3) Stems increase in diameter
   b) Herbaceous plants
      1) No outer bark covering
      2) Not winter hardy
   c) Deciduous plants
      1) Woody plants
      2) Go through annual dormancy in which they drop leaves
      3) Live more than one year
   d) Narrow-leaf evergreens
      1) Cone-bearing
      2) Needle-like leaves
      3) Keep their leaves all year, but periodically drop a few
   e) Broad-leaf evergreens
      1) Not cone-bearing
      2) Broader leaves than narrow-leaf evergreens
      3) Keep their leaves all year, but periodically drop a few
   f) Shrubs
      1) Multiple woody stems
      2) Resemble trees, but not as tall
      3) Can be deciduous, or broad- or narrow-leaf evergreens

2. Ask students the differences between vines and groundcovers.

What are the differences between vines and groundcovers?

a) Vines
  1) Woody or herbaceous
  2) Flowering or nonflowering
  3) Grow upright with support; otherwise trail on ground
  4) Attach themselves by tendrils or twining
b) Groundcovers
  1) Herbaceous or woody
  2) Flowering or nonflowering
  3) Trailing or compact
  4) Cover the ground
  5) Help prevent erosion

3. Ask students what "annual" means. Ask students to tell differences between annual and perennial plants.

What are the differences between annual and perennial plants?

a) Annual
  1) Herbaceous plant
  2) Begins and ends its life cycle in one year
b) Perennial
  1) Herbaceous plant
  2) Annual dormancy
  3) Lives more than one year

4. Discuss the basic tree forms.

What is form; and what are the typical natural tree and shrub forms?

a) Form
  1) Branching habit
  2) Growth habit
b) Natural forms
  1) Oval
  2) Columnar
  3) Pyramidal or conical
  4) Weeping or pendulous
  5) Broad oval or spreading
  6) Irregular
  7) Vase-shaped
  8) Fastigate
  9) Horizontal spreading
  10) Upright spreading
  11) Mounded
  12) Trailing, carpet-like, or prostrate

5. Ask students to identify the parts of the stem.

What are the external parts of the stem; and the differences between the types of buds?

a) Terminal bud
  1) Bud at the tip of the stem where new growth starts

        2) Usually the largest bud
        3) Can be vegetative or flowering
    b) Axillary or lateral bud
        1) Bud found on the side of the stem
        2) Vegetative - narrow, giving rise to new leaves or stems
        3) Flowering - round and large, giving rise to flowers
    c) Node - point from which buds grow
    d) Internode - distance between two nodes
    e) Terminal bud scar - scar left from previous year's bud
    f) Leaf scar - scar where leaf was attached to stem
    g) Lenticels - breathing pores found scattered around stem

6. Ask the students to list characteristics of a leaf that would aid in identification.

    What are the leaf structures and arrangements that help in plant identification?

    a) Parts of a leaf
        1) Petiole
        2) Base
        3) Blade - surface texture
            (a) Glabrous
            (b) Pubescent
            (c) Glacous
    b) Arrangement of leaves and buds
        1) Alternate
        2) Opposite
        3) Whorled
    c) Types of netted venation
        1) Pinnate
        2) Palmate
    d) Types of leaves
        1) Simple
        2) Compound
            (a) Palmate
            (b) Pinnate
            (c) Bi-pinnate
            (d) Trifoliate
    e) Leaf anatomy
        1) Leaf shapes
        2) Margin shapes
        3) Base shapes
        4) Tip shapes

F. Other activity

Take a field trip to identify as many plant characteristics and structures as possible. Encourage students to make a leaf collection. Supply students with reference handouts including all of the identifying shapes and structures.

G. Conclusion

There are many characteristics by which plants can be identified. Each tree or shrub has its own distinct form, stem structure, bud shape and size, leaf structure, and arrangement that makes it unique.

H. Competency

Identify the basic structural features of trees and shrubs.

I. Answers to Evaluation

1. c
2. c
3. b
4. a
5. d
6. c
7. c
8. b
9. a
10. d
11. d

UNIT III - IDENTIFICATION Name ____________________

Lesson 1: Identifying Characteristics of Trees and Shrubs Date ____________________

EVALUATION

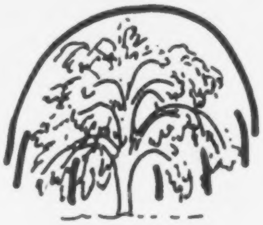
Circle the letter that corresponds to the best answer.

1. Which of the following is not a type of leaf arrangement on the stem?

   a. Alternate
   b. Opposite
   c. Parallel
   d. Whorled

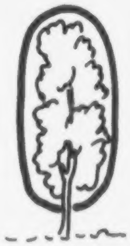
2. The tree pictured below has which of the following forms?

   a. Broad
   b. Columnar
   c. Pendulous
   d. Spreading



3. The tree pictured below has which of the following forms?

   a. Broad
   b. Columnar
   c. Pendulous
   d. Spreading



4. The distance between which of the following shows one year's growth?

   a. Bud scale scars
   b. Leaf petiole scars
   c. Lenticels
   d. Nodes

5. Where does new growth start?

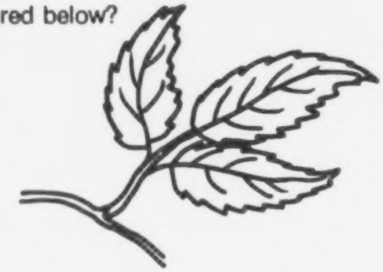
   a. Bud scale scar
   b. Lateral bud
   c. Node
   d. Terminal bud

6. Which of the following is not true of netted venation?

   a. Can be pinnate
   b. Can be palmate
   c. Occurs in monocots
   d. Occurs in dicots

7. Which of the following leaf types is pictured below?

   a. Palmate
   b. Bi-pinnate
   c. Trifoliate
   d. Pinnate



8. Which of the following does not have an outer bark covering?

   a. Woody plant
   b. Herbaceous plant
   c. Broad-leaf evergreen
   d. Narrow-leaf evergreen

9. How long would annuals be expected to grow?

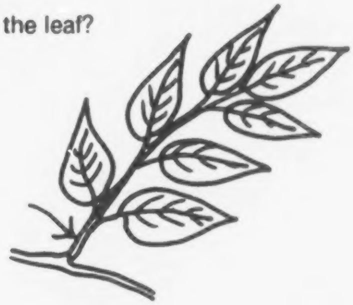
   a. One growing season
   b. Six months
   c. One year
   d. Several years

10. Out of what stem part do all buds grow?

    a. Terminal bud scars
    b. Leaf petiole scars
    c. Lenticels
    d. Nodes

11. The arrow is pointing to what part of the leaf?

    a. Base
    b. Blade
    c. Midrib
    d. Petiole



Lesson 2: Identifying Characteristics of Narrow-Leaf Evergreens

Objective: The student will be able to describe the identifying characteristics of narrow-leaf evergreens.

Study Questions

1. **What are the three types of leaves found on narrow-leaf evergreen plants?**
2. **What are distinguishing characteristics for each of the following genera: Pinus (Pine), Cedrus (Cedar), Picea (Spruce), Tsuga (Hemlock), Abies (Fir), Thuja (Arborvitae), Juniperus (Juniper), and Taxus (Yew)?**

Reference

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.

UNIT III - IDENTIFICATION

Lesson 2: Identifying Characteristics of Narrow-Leaf Evergreens

TEACHING PROCEDURES

A. Review

Review the previous lesson.

B. Motivation

Evergreens are unique in character since they remain green year-round. Identification is not always easy. Learning a few unique characteristics can make identification a simpler task.

C. Assignment

D. Supervised study

E. Discussion

1. Ask the students what they know about narrow-leaf evergreens. More than likely, they will say that they are green year-round and have narrow leaves. Point out that evergreens have unique leaf types.

   What are the three types of leaves found on narrow-leaf evergreens?

   a) Awl-like
      1) Sharp to the touch
      2) Shaped like an awl (pointed)
      3) Found in young juniper
   b) Scale-like
      1) Scales overlap like shingles on a roof
      2) Forms a flat spray
      3) Soft to the touch
      4) Found in Arborvitae and mature juniper
   c) Needle-like
      1) Attached by fascicles or sheaths - pine
      2) Linear-shaped needles - fir, spruce, cedar and yew
   d) Other characteristics
      1) Length of needles - environmental conditions can make this misleading
      2) Stiffness of needles to the touch
      3) Shape of needle - square or triangular, etc.

2. One of the best ways to identify narrow-leaf evergreens is to know the general characteristics of the genus. Some unique features help in this identification process.

   What are distinguishing characteristics for each of the following genera: Pinus (Pine), Cedrus (Cedar), Picea (Spruce), Tsuga (Hemlock), Abies (Fir), Thuja (Arborvitae), Juniperus (Juniper), and Taxus (Yew)?

   a) Pinus (Pine)

        1) Long, needle-like leaves
        2) In clusters of two to five
        3) Spirally arranged on stem
    b) Cedrus (Cedar)
        1) Short, stiff, needle-like leaves
        2) Triangular-shaped
        3) Scattered along the branch
        4) Clustered on spurs; ten or more leaves per cluster
    c) Picea (Spruce)
        1) Short, stiff, needle-like leaves of uniform width
        2) Sharp-pointed
        3) Scattered all around twig
        4) Twigs very rough after needles fall
    d) Tsuga (Hemlock)
        1) Flat, linear, needle-like leaves, less than three-fourths inch long
        2) On short stalk in ranks of two
        3) Notched at end of leaf
        4) White beneath
    e) Abies (Fir)
        1) Flat, linear, needle-like leaves
        2) Spirally arranged on stem
        3) Stem smooth after leaves fall
    f) Thuja (Arborvitae)
        1) Small, scale-like leaves in pairs
        2) Arise on short, central stalk
        3) Leaves overlap tightly on branchlet
        4) Soft to the touch
    g) Juniperus (Juniper)
        1) Mixture of awl-like and scale-like leaves
        2) Scale-like leaves surround stem tightly
        3) Awl-like leaves point out
        4) Harsh to the touch
    h) Taxus (Yew)
        1) Flat, linear, needle-like leaves
        2) Mostly green on both sides
        3) In two ranks on the stem
        4) Curved and scythe-shaped

F. Other activity

Have students bring in samples of evergreen stems to identify in class.

G. Conclusion

Although there are other detailed characteristics that can be used, these are a few to be used for general identification of narrow-leaf evergreens..

H. Competency

Identify the distinguishing characteristics for common narrow-leaf evergreens.

I. Answers to Evaluation

1. a
2. c
3. d
4. c
5. b
6. c
7. d
8. h
9. g
10. e
11. a
12. b
13. f

UNIT III - IDENTIFICATION

Name ____________________

Lesson 2: Identifying Characteristics of Narrow-Leaf Evergreens

Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Of the three types of narrow-leaf evergreen leaves, which is found on a juniper in the juvenile stage of growth?

    a. Awl-like
    b. Needle-like
    c. Owl-like
    d. Scale-like

2. Which type leaves are most characteristic of pines?

    a. Awl-like
    b. Linear
    c. Needle-like
    d. Scale-like

3. Which type leaves are most characteristic of arborvitae?

    a. Awl-like
    b. Linear
    c. Needle-like
    d. Scale-like

4. Which characteristic can be used to identify narrow leaf evergreens but is unreliable because environmental conditions may cause variation?

    a. Leaf shapes (square, triangular)
    b. Leaf types
    c. Length of needles
    d. Stiffness or softness

5. Which type leaves are characteristic of yews?

    a. Awl-like
    b. Linear
    c. Needle-like
    d. Scale-like

Match the genus name to the picture.

6. ____ Pinus

7. ____ Tsuga

8. ____ Taxus

9. ____ Juniperus

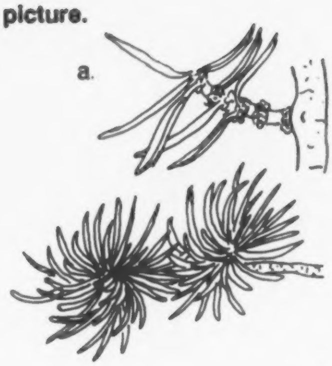
10. ____ Abies

11. ____ Cedrus

12. ____ Picea

13. ____ Thuja

a.



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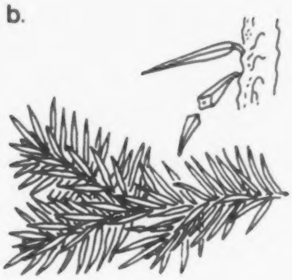

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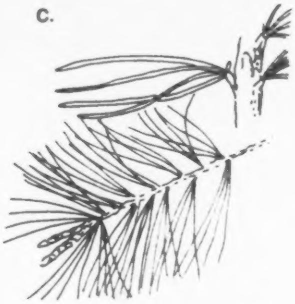

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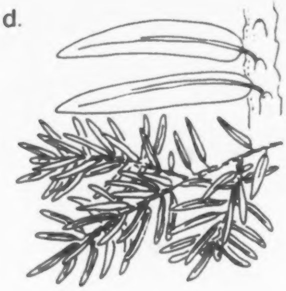

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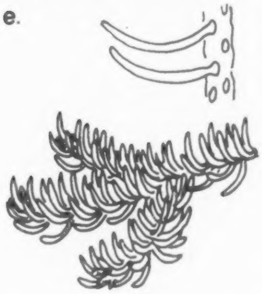

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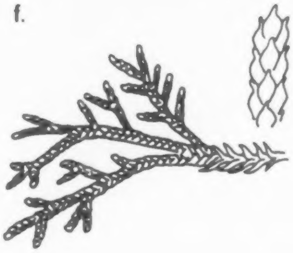

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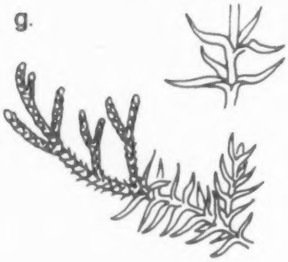

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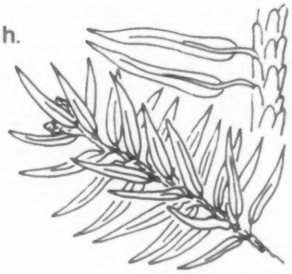


UNIT III - IDENTIFICATION

Lesson 3: Identifying Trees

Objective: The student will be able to identify selected shade, flowering, and evergreen trees.

Study Questions

1. **What are the key identifying characteristics of selected shade trees?**
2. **What are the key identifying characteristics of selected flowering trees?**
3. **What are key identifying characteristics of selected evergreen trees?**

References

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
2. Work Sheet
    a) WS 3.1: Leaf Identification

UNIT III - IDENTIFICATION

Lesson 3: Identifying Trees

TEACHING PROCEDURES

A. Review

Review the previous lesson.

B. Motivation

Ask for two student volunteers. Direct the discussion by asking questions about unique characteristics of each student including height, hair color, and other distinguising differences. Point out that trees and plants also have unique characteristics that distinguish them from one another. They will study these characteristics so they can identify each tree.

C. Assignment

D. Supervised study

E. Discussion

1. Take the students on a field trip to a park, school grounds, or nursery where they can actually see the trees. Point out to the students the form, branching habit, and growth habit. Point out how the tree fits into the landscape. Require the students to make a leaf collection. Have them attach each leaf to WS 3.1 and fill in the blanks. The same form will be used for Lessons 4, 5, and 7. WS 3.1 will be begun in this unit and finished in Unit X - Selecting and Using Plants in the Landscape. The students will have a complete record of the plants when finished. They will also see how this unit fits together. The students will need one sheet for each plant.

If a field trip is not feasible, collect samples before class for students to observe. Place the samples in bottles of water to keep them fresh. This may be combined with viewing slides that demonstrate the form and growth habit of the trees.

NOTE: All tree identification tables are in the student reference.

What are key identifying characteristics of selected shade trees?

a) Acer rubrum - red maple
b) Acer saccharum - sugar maple
c) Betula nigra - river birch
d) Betula pendula - European white birch
e) Fraximus Pennsylvania - green ash
f) Gleditsia triacanthos inermis - honey locust
g) Liquidambar styraciflua - sweet gum
h) Liriodendron tulipifera - tulip tree
i) Platanus occidentalis - sycamore
j) Quercus palustris - pin oak
k) Tilia cordata - littleleaf linden

2. Have students continue collecting leaves and filling out WS 3.1.

What are key identifying characteristics of selected flowering trees?

a) Albizia julibrissin - mimosa
b) Cercis canadensis - eastern redbud
c) Cornus florida - flowering dogwood
d) Crataegus phaenopyrum - Washington hawthorne
e) Koelreuteria paniculata - golden raintree
f) Magnolia soulangiana - saucer magnolia
g) Malus species - flowering crabapple
h) Pyrus calleryana "Bradford" - Bradford pear

3. The students should continue collecting leaves and filling out WS 3.1.

What are key identifying characteristics of selected evergreen trees?

a) Ilex opaca - American holly
b) Juniperus virginiana - Eastern red cedar
c) Magnolia grandiflora - southern magnolia
d) Picea abies - Norway spruce
e) Picea pungens "Glauca" - blue spruce
f) Pinus nigra - Austrian pine
g) Pinus strobus - white pine
h) Pinus sylvestris - Scotch pine
i) Tsuga canadensis - hemlock

F. Other activity

Have the student sketch a leaf for each of the trees listed, and label the key parts.

G. Conclusion

Tree form, branching and growth habit, stem and bark characteristics, buds, and leaf characteristics, are all essential information in identifying trees.

H. Competency

Identify selected trees.

I. Evaluation

There are a number of ways to test over this unit. The method used will depend on individual circumstances. Three suggestions follow. Answers will be left to the discretion of the teacher. In all evaluations, the common and botanical names should be written by the student.

1) Collect live samples from trees in the local area. Tag them with numbers or letters. Set them in bottles of water to keep them fresh and alive. Set them around the room in stations. Have students go from station to station identifying each sample. Allow only one to three students at a station at a time (preferably one). Allow only two to three minutes, or any workable time limit, at each station. Call time and have the students change stations. Repeat until each student has visited each station.

2) If feasible, tag live trees outdoors and have the students identify them.

3) If live samples or trees are not available in the area, a slide set can be used. Flash the picture of each species on a screen for a given amount of time. Have the students write the name of each tree.

H. Answers to WS 3.1

The instructor will need to determine if answers are appropriate.

UNIT III - IDENTIFICATION WS 3.1

Lesson 3: Identifying Trees

Work Sheet 3.1: Leaf Identification

Directions: For each tree specified, collect a leaf and attach it to this sheet. Fill in the information needed in the following blanks. (A separate sheet is needed for each tree.)

Botanical Name:____________________

Common Name:__________ Size:__________

Branching Habit:__________ Zone:__________

Leaf Arrangement:______ Venation:______ Type:______

Leaf Shape:______ Surface:______ Texture:______

Leaf Color:______ Fall Color:______

Growth Habit:____________________

Fruit Color:______ Duration:______ Use:______

Flower Color:______ Duration:______ Fragrance:______

Stem Characteristics:____________________

Buds: Terminal______ Lateral______ Form:______

Light Requirement:____________________

Soil Requirement:____________________

Insects and Diseases:____________________

Landscape Uses:____________________

Notes:____________________

____

Lesson 4: Identifying Shrubs

Objective: The student will be able to identify selected flowering and evergreen shrubs.

Study Questions

1. **What are the key identifying characteristics of selected flowering shrubs?**
2. **What are the key identifying characteristics of selected evergreen shrubs?**

References

1. Landscaping and Turf Management. (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
2. Work Sheet
    a) WS 4.1: Shrub Identification

Lesson 4: Identifying Shrubs

TEACHING PROCEDURES

A. Review

Review the previous lesson.

B. Motivation

Shrubs are just as important to a successful landscape as trees. Landscapers need to develop skill in identification of flowering and evergreen shrubs in order to select appropriate plants for a landscape.

C. Assignment

D. Supervised study

E. Discussion

1. Take students on a field trip to a park, school grounds, or nursery where they can actually see the shrubs. Point out to the students the form, branching habit, and growth habit. Point out how the shrub fits into the landscape. Have students continue the leaf collection from Lesson 3 using leaves from shrubs. Have them attach each leaf to WS 4.1 and fill in the blanks. They will need one sheet for each plant.

   If a field trip is not feasible, collect samples before class for students to observe. Place the samples in bottles of water to keep them fresh. This may be combined with viewing slides that demonstrate the form and growth habit of the shrubs.

   NOTE: All shrub identification tables are in the student reference.

   What are key identifying characteristics of selected flowering shrubs?

   a) Berberis thunbergii - japanese barberry
   b) Cornus sericea - redosier dogwood
   c) Chaenomeles speciosa - flowering quince
   d) Euonymus alatus - winged euonymus
   e) Forsythia x intermedia - border forsythia
   f) Ligustrum japonicum - wax leaf pivot
   g) Nandina domesticum - nandina
   h) Pyracantha coccinea - scarlet firethorn
   i) Salix gracilistyla - rosegold pussywillow
   j) Spirea vanhouttei - Vanhoutte spirea
   k) Syringa vulgaris - common lilac

2. Have students continue collecting leaves and filling out WS 4.1.

   What are key identifying characteristicc of selected evergreen shrubs?

   a) Buxus microphylla - Korean boxwood

b) Euonymus kirutschovicus - spreading euonymus
c) Ilex creata "helleri" - Japanese holly
d) Juniperus chinensis "hetzii" - hetzii juniper
e) Juniperus chinensis "phitzeriana" - phitzer juniper
f) Mahonia aquifalium - Oregon grape holly
g) Pinus mugo - mugo pine
h) Rhododendron catawbiense - catawba rhododendron
i) Taxus cuspidata - Japanese yew
j) Thuja occidentalis - Eastern or American arborvitae or white cedar
k) Viburnum x rhytidophyllodies - leather leaf viburnum

F. Other Activity

Have the student sketch a leaf for each of the shrubs listed, and label the key parts.

G. Conclusion

Shrub form, branching and growth habit, stem and bark characteristics, buds, and leaf characteristics, are all essential information in identifying shrubs.

H. Competency

Identify selected shrubs.

I. Evaluation

There are a number of ways to test over this lesson. The method used will depend on individual circumstances. Three suggestions follow. Answers will be left to the discretion of the teacher. In all evaluations, the common and botanical names should be written by the student.

1) Collect live samples from shrubs in the local area. Tag them with numbers or letters. Set them in bottles of coater to keep them fresh and alive. Set them around the room in stations. Have students go from station to station identifying each sample. Allow only one to three students at a station at a time (preferably one). Allow only two to three minutes, or any workable time limit, at each station. Call time and have the students change stations. Repeat until each student has visited each station.

2) If feasible, tag shrubs outdoors and have the students identify them.

3) If live samples or trees are not available in the area, a slide set can be used. Flash the picture of each species on a screen for a given amount of time. Have the students write the name of each shrub.

H. Answers to Work Sheet

The instructor will need to determine if answers are appropriate.

UNIT III - IDENTIFICATION WS 4.1

Lesson 4: Identifying Shrubs

Work Sheet 4.1: Leaf Identification

Directions: For each shrub specified, collect a leaf and attach it to this sheet. Fill in the information needed in the following blanks. (A separate sheet is needed for each shrub.)

Botanical Name:____

Common Name:____________________ Size:____________________

Branching Habit:____________________ Zone:____________________

Leaf Arrangement:__________ Venation:______ Type:____________________

Leaf Shape:__________ Surface:______ Texture:____________________

Leaf Color:__________ Fall Color:____________________

Growth Habit:____

Fruit Color:__________ Duration:______ Use:____________________

Flower Color:__________ Duration:______ Fragrance:____________________

Stem Characteristics:____

Buds: Terminal__________ Lateral__________ Form:____________________

Light Requirement:____

Soil Requirement:____

Insects and Diseases:____

Landscape Uses:____

Notes:____

____

UNIT III - IDENTIFICATION

Lesson 5: Identifying Vines, Ground Covers, and Perennials

Objective: The student will be able to identify selected vines, ground covers, and perennials commonly used in the landscape.

Student Questions

1. **What are key identifying characteristics of selected vines and ground covers?**
2. **What are key identifying characteristics of selected perennials?**

References

1. Landscaping and Turfgrass Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
2. Work Sheet
    a) WS 5.1: Vine, Ground Cover, and Perennial Identification

UNIT III - IDENTIFICATION

Lesson 5: Identifying Vines, Ground Covers, and Perennials

TEACHING PROCEDURES

A. Review

Review the previous lesson.

B. Motivation

Bring in examples of several different vines, ground covers, and perennials in potted containers for the class to look at. Explain that each has a different function in the landscape.

C. Assignment

D. Supervised study

E. Discussion

1. Take students on a field trip to a park, school grounds, or nursery where they can actually see the plants. Point out to the students the form, branching habit, and growth habit. Point out how the plants fit into the landscape. Require the students to make a leaf collection. The instructor should determine the number of plants to be collected. Work Sheet 5.1 will need to be duplicated for the number of plants determined. Have them attach the leaf to WS 5.1 and fill in the blanks. The same form is used for Lessons 3, 4, and 7, and will be combined with Unit X - Selecting and Using Plants in the Landscape.

If a field trip is not feasible, collect samples before class for students to observe. Place the samples in bottles of water to keep them fresh. This may be combined with viewing slides that demonstrate the form and growth habit of the plants. If live plant species are not available, obtain pictures of the plants.

NOTE: All identification tables are in the student reference.

What are key identifying characteristics of selected vines and ground covers?

a) Ajuga reptans - ajuga or bugleweed
b) Celastrus scandens - American bittersweet
c) Coronilla varis - crown vetch
d) Euonymus fortunei "Radicans" - bigleaf wintercreeper
e) Hedra helix - English ivy
f) Juniperus horizontalis - creeping juniper
g) Lonicera japonica "Halliana" - Hall's honeysuckle
h) Vinca minor - creeping myrtle or periwinkle

2. The students should continue taking leaf or branch collections and completing WS 5.1.

What are key identifying characteristics of selected perennials?

a) Artemisia schmidtiana - silver mound
b) Astilbe x ardendsii - false spirea astilbe

c) Aquilegia hybrids - columbine
d) Chrysanthemum x morifolium - garden mum
e) Coreopsis lanceolata - coreopsis
f) Hemerocallis hybrids - day lily
g) Heuchera sanguinea - coral bells
h) Hosta species - plantain lily or hosta
i) Liriope spicata - lily turf
j) Phlox subulata - creeping phlox

F. Other activity

Have the students sketch the most unique identifying characteristic of the plants in this lesson.

G. Conclusion

The growth habit is one of the most distinguishing characteristics between ground covers and vines. Many ground covers can be used as vines, given the proper support to grow on. Perennials are often identified by the flower, or the form of the plant as a whole.

H. Competency

Identify ground covers, vines, and perennials.

I. Evaluation

There are a number of ways to test over this lesson. The method used will depend on individual circumstances. Three suggestions follow. Answers will be left to the discretion of the teacher. In all evaluations, common and botanical names should be written by the student.

1) Collect live samples from plants in the local area. Tag them with numbers or letters. Set them in bottles of water to keep them fresh and alive. Set them around the room in stations. Have students go from station to station identifying each sample. Allow only one to three students at a station at a time (preferably one). Allow only two to three minutes, or any workable time limit, at each station. Call time and have the students change stations. Repeat until each student has visited each station.

2) If feasible, tag live plants outdoors and have the students identify them.

3) If live samples are not available in the area, a slide set can be used. Flash the picture of each species on a screen for a given amount of time. Have the students write the name of each plant.

H. Answers to WS 5.1.

The instructor will need to determine if answers are appropriate.

UNIT III - IDENTIFICATION WS 5.1

Lesson 5: Identifying Vines, Ground Covers, and Perennials

Work Sheet 5.1: Vine, Ground Cover, and Perennial Identification

Directions: Collect a leaf from each specified plant. Attach it to this sheet. Fill in information needed in the following blanks. (One plant per sheet.)

Botanical Name: ____________________

Common Name: __________ Size: __________

Branching Habit: __________ Zone: __________

Leaf Arrangement: ______ Venation: ______ Type: __________

Leaf Shape: ______ Surface: ______ Texture: __________

Leaf Color: ______ Fall Color: __________

Growth Habit: ____________________

Fruit Color: ______ Duration: ______ Use: __________

Flower Color: ______ Duration: ______ Fragrance: __________

Stem Characteristics: ____________________

Buds: Terminal ______ Lateral ______ Form: __________

Light Requirement: ____________________

Soil Requirement: ____________________

Insects and Diseases: ____________________

Landscape Uses: ____________________

Notes: ____________________

____

UNIT III - IDENTIFICATION

Lesson 6: Identifying Characteristics of Grasses

Objective: The student will be able to identify the characteristics of grasses used in identification.

Study Questions

1. **What are the structural parts of grasses?**
2. **How can the roots, blade and tip shapes, collar, venation, sheath, auricle and ligule help identify grasses?**
3. **How can the type of inflorescence help identify grasses?**

References

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia; Instructional Materials Laboratory, 1990.
2. Transparency Master
    - a) TM 6.1: Structural Parts of Grasses

UNIT III - IDENTIFICATION

Lesson 6: Identifying Characteristics of Grasses

TEACHING PROCEDURES

A. Review

Review previous lesson.

B. Motivation

Have grass plants in pots to show the students. These should be grown ahead of time in the greenhouse or classroom. Let the students observe the plants. Have magnifying glasses available for the students to see the structural parts.

C. Assignment

D. Supervised study

E. Discussion

1. Ask the students to name the structural parts of the grasses. Have an example of a plant in class so they can see the actual parts along with the schematic drawings. Try to get a plant with roots and flower. Show TM 6.1 Structural Parts of Grasses.

What are the structural parts of grasses?

a) Roots
b) Node
c) Internode
d) Leaf bud
e) Collar
f) Auricle
g) Ligule
h) Leaf sheath
i) Cull or stem
j) Flower

2. Ask the students how the structural parts can help in identification of grasses.

How can the roots, blade and tip shapes, collar, venation sheath, auricle and ligule help identify grasses?

a) Roots
    1) Annual
        (a) Fibrous
        (b) Weak
        (c) Pulls easily from ground
    2) Perennial
        (a) Fibrous
        (b) Strong
        (c) Plant breaks from roots and rhizome
b) Leaf blade shapes
    1) Tapering to tip
    2) Boat-shaped tip
    3) Parallel-sided
    4) Narrowed to base

d) Collar
    1) Broad
    2) Narrow
    3) Divided
    4) Oblique
    5) Hairy
    6) Margins hairy
e) Venation
    1) Rolled
    2) Folded
f) Sheath
    1) Split
    2) Split, margins overlapping
    3) Closed
g) Auricle
    1) Large
    2) Small
    3) Absent
h) Ligule Shapes
    (a) Acuminate
    (b) Acute
    (c) Rounded
    (d) Truncate
    (e) Absent

3. Ask the students to describe different shapes of flowers they have seen on grasses. Have students bring examples of grass flowers.

How does the type of inflorescence help identify grasses?

a) Spike
b) Raceme
c) Panicle

F. Other activity

Either go on a field trip or have examples or different grasses (the six listed in Unit III, Lesson 7) so the students can relate the schematics to the actual plant.

G. Conclusion

Grasses need to be identified in their vegetative state since they do not flower until late in the season. The plant species determines the cultural care a lawn needs. The structural parts of grasses are used to identify the vegetative plant.

H. Competency

Identify the basic structural features of grasses.

I. Answers to Evaluation

1. d
2. b
3. b
4. a
5. c

UNIT III - IDENTIFICATION

Name ____________________

Lesson 6: Identifying Characteristics of Grasses

Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. What is the arrangement of the leaves in the bud shoot?

   a. Leaf pinnation
   b. Sheath
   c. Spike
   d. Venation

2. What is the part of the grass plant that projects upwardly where the blade and the sheath connect?

   a. Apex
   b. Ligule
   c. Node
   d. Sheath

3. Which type of inflorescence is most common?

   a. Internode
   b. Panicle
   c. Raceme
   d. Spike

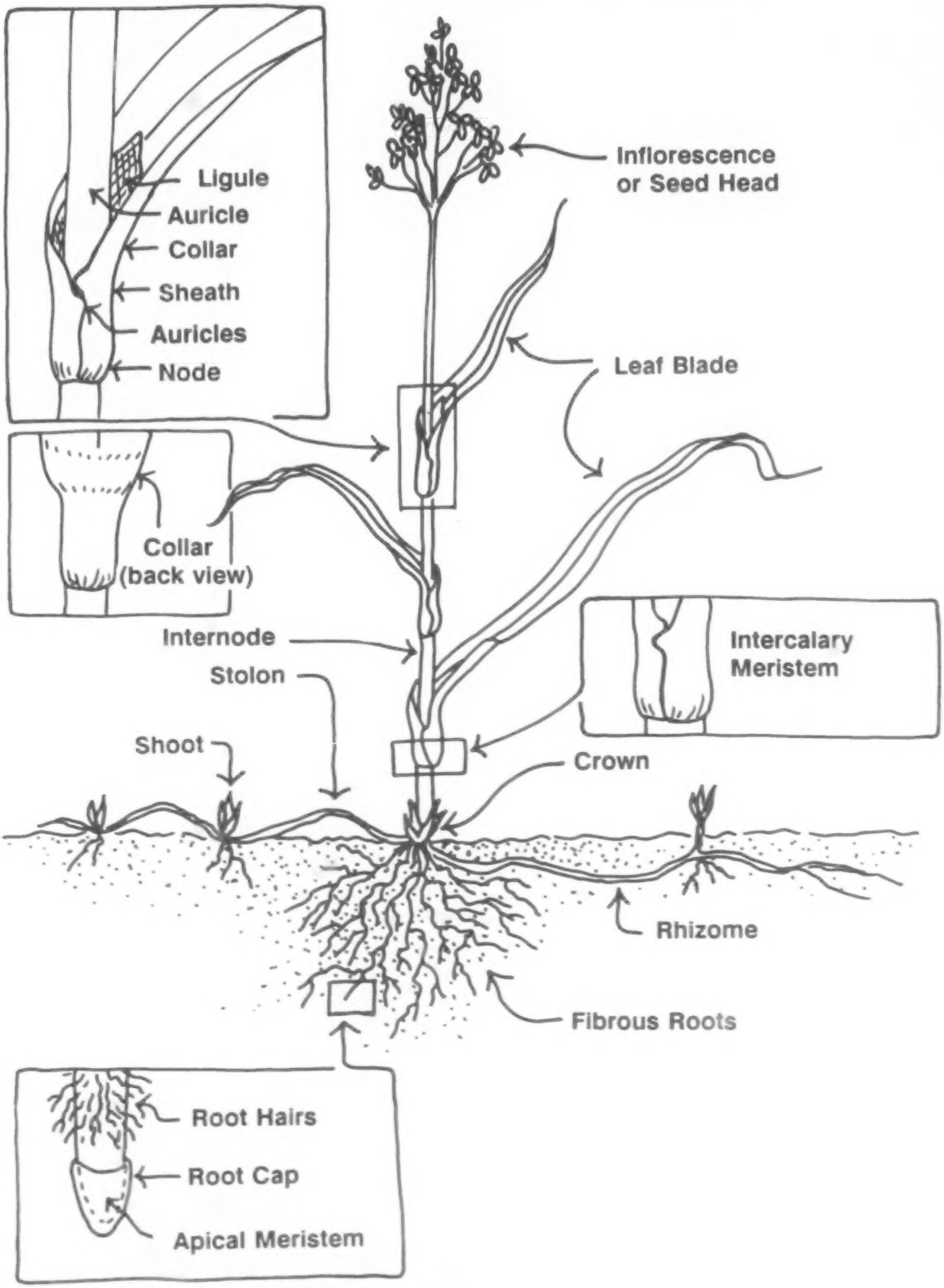
4. Which of the following is part of a grass plant?

   a. Collar
   b. Lapel
   c. Seam
   d. All of the above

5. Which type of grass has a stronger root system?

   a. Annual
   b. Semi-annual
   c. Perennial
   d. None of the above

Structural Parts of Grasses


Ligule
Auricle
Collar
Sheath
Auricles
Node
Collar (back view)
Internode
Stolon
Shoot
Inflorescence or Seed Head
Leaf Blade
Intercalary Meristem
Crown
Rhizome
Fibrous Roots
Root Hairs
Root Cap
Apical Meristem

UNIT III - IDENTIFICATION

Lesson 7: Identifying Grasses

Objective: The student will be able to identify the six major turfgrasses used in Missouri.

Study Question

1. **What are the key identifying characteristics of the six major turfgrasses used in Missouri?**

Reference

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia; Instructional Materials Laboratory, 1990.

UNIT III - IDENTIFICATION

Lesson 7: Identifying Grasses

TEACHING PROCEDURES

A. Review

Review previous lesson.

B. Motivation

There are six major trufgrasses that are commonly used in Missouri. It is helpful for the landscaper to know the identifying characteristics of each.

C. Assignment

D. Supervised study

E. Discussion

1. Ask the students to identify the six turfgrasses.

What are the key identifying characteristics of the six major turfgrasses used in Missouri?

The characterisitcs of the following grasses are located in Table 7.1 in the Student Reference.

a) Cynodon dactylon - Bermudagrass
b) Zoysia japonica - Zoysia grass
c) Lolium perenne - Perennial ryegrass
d) Festuca rubra - Red fescue
e) Festuca arundinacea - Tall fescue
f) Poa pratensis - Kentucky bluegrass

F. Other activity

Try to have live samples that the students can look at and study. Have hand lenses for them to look through.

G. Conclusion

Grasses must be identified in their vegetative state since their flowers only appear late in the season.

H. Competency

Identify the six major turfgrasses used in Missouri.

I. Answers to Evaluation

There are a number of ways to test over this lesson. The method used will depend on individual circumstances. Three suggestions follow. Answers will be left to the discretion of the teacher. In all evaluations, the common and botanical names should be written by the student.

1) Collect live samples and tag them with numbers or letters. Set them around the room in stations. Have students go from station to station identifying each sample. Allow only one to three students at a station at a time (preferably one). Allow only two to three minutes, or any workable time limit, at each station. Call time and have the students change stations. Repeat until each student has visited each station.

2) If feasible, tag turfgrasses outdoors and have the students identify them.

3) If live samples are not available in the area, a slide set can be used. Flash the picture of each species on a screen for a given amount of time. Have the students write the name of each turfgrass.

UNIT IV - TOOL IDENTIFICATION AND MAINTENANCE

Lesson 1: Hand Tools and Equipment

Objective: The student will be able to identify and maintain the common hand tools used in the landscape and turfgrass industries.

Study Questions

1. **What hand tools and equipment are used in the landscape and turfgrass industries?**
2. **What types of maintenance should be performed routinely on hand tools and equipment?**
3. **What safety precautions should be taken when using and sharpening hand tools?**

References

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
2. Job Sheets
   a) JS 1.1: Restoration of Wooden Handles
   b) JS 1.2: Restoration of Metal Surfaces

UNIT IV - TOOL IDENTIFICATION AND MAINTENANCE

Lesson 1: Hand Tools and Equipment

TEACHING PROCEDURES

A. Introduction

Tools are important to the landscape and turfgrass industries. Being familiar with the variety of available tools and how to use and maintain them, aids a landscaper in handling each task efficiently.

B. Motivation

Landscapers are able to complete work more easily when they are able to properly identify, use, and maintain tools. Routine maintenance prolongs the usefulness of the tools.

C. Assignment

D. Supervised study

E. Discussion

1. Show a number of hand tools and equipment to the class. Ask students to name them and explain what job the tool performs.

What hand tools and equipment are used in the landscape and turfgrass industries?

a) Pruning saw
b) Bow saw
c) Axe
d) Pruning shears
e) Lopping shears
f) Hedge shears
g) Hand trowel
h) Cultivators
i) Garden spade
j) Sharp shooter
k) Round-pointed shovel
l) Square-pointed shovel
m) Scoop shovel
n) Spading fork
o) Pitch fork
p) Garden rake
q) Lawn or leaf rake
r) Garden hoe
s) Action hoe
t) Bulb planter
u) Wheelbarrow
v) Spreader
w) Sod roller
x) Turf edger
y) Post-hole digger
z) Weed cutter
aa) Mattock
bb) Pick

2. Ask students to describe different maintenance tasks that should be performed routinely on cars and trucks.

What types of maintenance should be performed routinely on hand tools and equipment?

a) Restore wood surfaces.
b) Restore metal surfaces.
c) Sharpen tools.

3. Ask students if they or anyone they know has been hurt while using hand tools. Ask students how this could have been prevented.

   What safety precautions should be taken when using and sharpening hand tools?

   a) Do not wear loose fitting clothes.
   b) Wear eye protection.
   c) Wear gloves.
   d) Be conscious of where others are working.
   e) Be alert to surrounding conditions.

F. Other Activities

1. Assign each student a hand tool and have them explain to the class how it should be maintained.

2. Demonstrate how to sharpen tools.

3. Have students sharpen tools.

4. Take a field trip to local store to see tools.

G. Conclusion

Routine maintenance of hand tools will prolong the life of the tools. Restoration of wood and metal surfaces and sharpening tools are some routine maintenance tasks. Safety should always be practiced when working with tools.

H. Competency

Identify and maintain hand tools and equipment.

I. Answers to Evaluation

1. c
2. b
3. c
4. a

Name ____________________

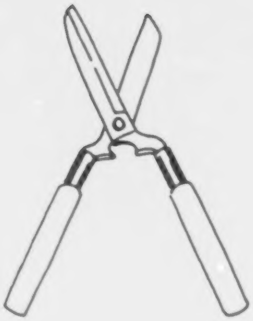
Lesson 1: Hand Tools and Equipment

Date ____________________

EVALUATION

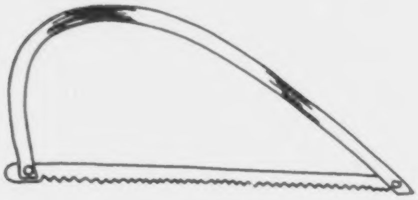
Circle the letter that corresponds to the best answer.

1. What is the tool pictured below?



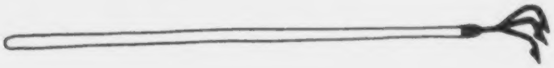
   a. Bow saw
   b. Hand pruners
   c. Hedge shears
   d. Pruning saw

2. What is the tool pictured below?



   a. Anvil-type pruning shears
   b. Bow saw
   c. Garden hoe
   d. Hand pruners

3. What is the tool pictured below?



   a. Anvil-type pruning shears
   b. Bypass
   c. Cultivator
   d. Spading fork

4. Which is not an easy task of routine maintenance used to keep tools in good working condition?

   a. Waiting until tools show signs of wear and tear to repair them
   b. Sharpening tools
   c. Preventing rust
   d. Restoring wooden handles

Lesson 1: Hand Tools and Equipment

Job Sheet 1.1: Restoration of Wooden Handles

Objective: Upon completion of this job sheet, the student will be able to restore the wooden handle of a hand tool.

Materials and Supplies Needed:

1. Any hand tool with a wooden handle
2. Sandpaper (80 or 100 grit)
3. Soft cloths
4. Linseed oil
5. Any source of heat

Procedure:

1. Sand the wooden handle until smooth.

2. Heat the linseed oil.

   CAUTION: Be careful when applying heated linseed oil.

3. Using a soft cloth, rub the wooden handle with linseed oil.

4. Allow sufficient time for the linseed oil to dry.

5. With a second soft cloth, rub the wooden handle.

Lesson 1: Hand Tools and Equipment

Job Sheet 1.2: Restoration of Metal Surfaces

Objective: Upon completion of this job sheet, the student will be able to restore hand tools with a metal surface.

Materials and Supplies Needed:

1. Soft cloths
2. Any tool with a metal surface
3. Nonflammable cleaner (hot soapy, water)
4. Wire brush or steel wool with naval jelly
5. Silicon carbide paper and oil (S.A.E. 10 oil is suggested.)

Procedure:

1. Remove any soil from the metal surface.

2. Use a soft cloth to remove any grease or oil on the metal with hot, soapy water.

3. Use a wire brush or steel wool with naval jelly to remove any pitted rust in the metal.

4. Use silicon carbide paper and oil to remove scratches and add shine to the metal.

UNIT IV - TOOL IDENTIFICATION AND MAINTENANCE

Lesson 2: Power Tools

Objective: The student will be able to identify and maintain common power tools used in the landscape and turfgrass industries.

Study Questions

1. **What gas and electric powered tools are used in the landscape and turfgrass industries?**
2. **How should gas powered tools be maintained?**
3. **How should power tools be stored?**
4. **What safety precautions should be taken when handling gas and electric powered tools?**

References

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
2. Demonstration Sheet
    a) DS 2.1: Winterization of a Lawn Mower

UNIT IV - TOOL IDENTIFICATION AND MAINTENANCE

Lesson 2: Power Tools

TEACHING PROCEDURES

A. Review

Review the previous lesson.

B. Motivation

Power tools allow landscapers to handle larger maintenance and turfgrass jobs in less time than with hand tools, thus bringing larger financial gain.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students to list power tools that might be used in landscape and turfgrass industries.

What gas and electric powered tools are used in the landscape and turfgrass industries?

a) Gas-hand operated
    1) Chain saw
    2) Lawn mower
    3) Leaf blower/vacuum
    4) Rototiller
    5) Lawn aerator (core or slicer)
    6) String trimmer
    7) Edger
    8) Hedge trimmer
    9) Walk-behind mower
    10) Dethatcher
    11) Sod cutter
    12) Chipper/shredder
    13) Trencher
    14) Snow blower
b) Gas-large equipment
    1) Tree spade
    2) Stump remover
    3) Power sweeper
    4) Skid loader
    5) Front end loader
    6) Chipper
    7) Snow blade
    8) Lawn tractor
    9) Fork lift
c) Electric
    1) Lawn mower
    2) Chain saw

        3) Hedge trimmer
        4) String trimmer
        5) Edger

2. Ask students what types of routine maintenance should be practiced in caring for power tools.

   How should gas powered tools be maintained?

   1) Check and clean air cleaners and filters.
   2) Replace crankcase oil.
   3) Check and service spark plugs.

3. Ask students what should be done with a lawn mower during the winter months.

   How should power tools be stored?

   a) To store for a month or less
      1) Close fuel valve, drain carburetor.
      2) Fill tank with gas.
      3) Charge battery, if needed.
   b) To store for more than a month
      1) Drain fuel tank, run engine until dry.
      2) Change engine oil.
      3) Clean and replace filters, as needed.
      4) Clean exterior of tool.
      5) Loosen belts.
      6) Clean and lubricate wearing surfaces and coat drive chains with oil to prevent rusting.
      7) Place tool off the ground, if indoors; cover engine, if outdoors.

4. Ask students if they, or someone they know, were hurt while using power tools. Ask students how this could have been prevented.

   What safety precautions should be taken when handling gas and electric powered tools?

   a) Gas powered tools
      1) Keep hands and feet away from moving parts.
      2) Do not smoke while working with gas engines.
      3) Stop engine before refueling.
      4) Work with gasoline engines outdoors or in well-ventilated areas.
      5) Retain all safety shields in proper places.
      6) Operate ventilation system when working indoors.
   b) Electric powered tools
      1) Use only insulated tools.
      2) Do not use electric tools near water.
      3) Always use ground fault circuit interrupters.
      4) Do not use cracked extension cords or those that feel warm to the touch while in use.

F. Other Activities

1. Assign each student a power tool and have them explain to the class how it should be maintained.

2. Demonstrate how to clean and change air filters.

3. Demonstrate how to change the crankcase oil.

4. Demonstrate how to service the spark plugs.

5. Have students clean and change air filters.

6. Have students change the crankcase oil.

7. Have students service the spark plugs.

8. Have students winterize tools.

9. Demonstrate how to prepare a machine or engine for use in the spring.

G. Conclusion

Power tools can allow landscapers to do more work in less time than with hand tools and provide more financial gain. If power tools are well-maintained and properly stored, the usefulness of the tool will be prolonged. Be sure to follow safety precautions when working with power tools.

H. Competency

Identify, maintain, and safely use power tools.

I. Answers to Evaluation

1. b
2. c
3. a

4. Answers should include four of the following:
Do not wear loose fitting clothes.
Use sharp tools.
Wear eye protection.
Let others know when operating power tools.
Never smoke around gas.
Keep hands and feet away from moving parts.
Use gasoline engines outdoors.
Stop engine before refueling.
Keep safety shields in place.

UNIT IV - TOOL IDENTIFICATION AND MAINTENANCE

Name ____________________

Lesson 2: Power Tools

Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which is not a maintenance procedure for power tools?

   a. Change air cleaners and air filters.
   b. Change crankcase oil in a two-cycle engine.
   c. Change crankcase oil in a four-cycle engine.
   d. Maintain spark plugs.

2. Which is not a step in the winterization of power tools?

   a. Change oil.
   b. Drain remaining fuel in the engine.
   c. Tighten belts.
   d. Lubricate chains.

3. Which is not a proper safety precaution when handling electric powered tools?

   a. Work near wet areas, if careful.
   b. Use ground fault circuit interrupters.
   c. Do not use cracked extension cords.
   d. Use insulated tools.

Complete the following short answer question.

4. List four safety precautions that should be taken when working with gas powered tools.

   a.
   b.
   c.
   d.

Demonstration Sheet 2.1: Winterization of a Lawn Mower

Objective: Students will be shown the steps necessary to winterize a lawn mower.

Materials and Supplies Needed:

1. Lawn mower
2. Oil (see owner's manual of lawn mower)
3. Fuel filter (see owner's manual of lawn mower)
4. Oil for lubrication
5. Tarpaulin or blanket
6. Blocks or bricks

Procedure:

1. Drain fuel tank.
2. Run engine until dry.
3. Change the crankcase oil.
4. Clean and replace filters (e.g., air, fuel).
5. Clean the exterior of the lawn mower.
6. Loosen any belts.
7. Clean and lubricate chains.
8. Place lawn mower off the ground onto blocks or bricks.
9. Cover lawn mower with tarpaulin or blanket.

UNIT V - PESTICIDES

Lesson 1: General Pesticide Information

Objective: The student will be able to describe how various types of pesticides work.

Study Questions

1. **What is the disease triangle?**
2. **What are the four types of metamorphosis in the life cycle of insects?**
3. **What is the Integrated Pest Management approach to pest control?**
4. **What is the origin of pesticides?**
5. **What are the various types of pesticides?**
6. **How do pesticides work?**
7. **What are the various formulations of pesticides?**

Reference

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.

UNIT V - PESTICIDES

Lesson 1: General Pesticide Information

TEACHING PROCEDURES

A. Introduction

There are many types of pesticides. Knowing the types of pesticides and how they are used can be very beneficial to growing plants and keeping them healthy. Pesticides are any kinds of material used in the control of pests.

B. Motivation

Pesticides can be beneficial. They eradicate pests and keep them from destroying plants. If pests are left alone and are allowed to overtake a plant, there will be expense and work involved in replacing the plant.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students if they control diseases in their garden, on their houseplants, or in their yard.

   What is the disease triangle?

   The disease triangle is a combination of pathogen, host, and the environment which contributes to the growth of disease.

2. Ask students to explain the life cycle of a butterfly to illustrate the process of metamorphosis.

   What are the four types of metamorphosis in the life cycle of insects?

   a) No metamorphosis - no change in insect
   b) Gradual metamorphosis - egg, nymph, and adult
   c) Incomplete metamorphosis - egg, naiad, and adult
   d) Complete metamorphosis - egg, larva, pupa, and adult

3. Ask students how they control pests in their garden, on houseplants, and in the yard.

   What is the Integrated Pest Management approach to pest control?

   Integrated Pest Management uses a combination of cultural, biological, mechanical, and chemical control methods to aid in eliminating pests.

4. Ask students if they can explain what ingredients make up pesticides.

   What is the origin of pesticides?

   a) Inorganic
   b) Organic

c) Synthetic

5. Ask students to make a list of different types of pests.

   What are the various types of pesticides?

   a) Insecticides
   b) Herbicides
   c) Fungicides
   d) Rodenticides
   e) Miticides
   f) Aracicides
   g) Molluscicides
   h) Bactericides
   i) Nematocides

6. Ask students how they might control an insect that lives inside a plant or one that has chewing mouth parts.

   How do pesticides work?

   a) As stomach poisons
   b) As systemic poisons
   c) As contact poisons
   d) As fumigants

7. Ask students if all pesticides are applied to plants in the same way. Ask them some of the different ways they are applied.

   What are the various formulations of pesticides?

   a) Liquid form
      1) Emulsifiable concentrates (EC or C)
      2) Solutions (S)
      3) Flowables (FL or L)
      4) Aerosols (A)
      5) Liquified gases
   b) Dry form
      1) Dusts (D)
      2) Granules (G)
      3) Wettable powders (WP)
      4) Soluble powders (SP)
      5) Baits (B)

F. Other Activities

1. Walk through a greenhouse to check for pests.

2. Walk through school grounds looking for different types of pests.

3. Have students make a poster of different types of pests.

G. Conclusion

There are many types of pesticides used to control pests in the home, yard, and garden.

H. Competency

Describe how various types of pesticides work.

I. Answers to Evaluation

1. d
2. d
3. a
4. b
5. d
6. c
7. b
8. c
9. a
10. e
11. b
12. d
13. c
14. a
15. f
16. b

UNIT V - PESTICIDES

Name ____________________

Lesson 1: General Pesticide Information

Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. What type(s) of control is (are) included in Integrated Pest Management?

   a. Chemical control only
   b. Chemical and biological control
   c. Cultural and mechanical control
   d. Cultural, mechanical, biological, and chemical control

2. What are the three parts of a disease triangle?

   a. Environment, host, insect
   b. Host, insect, pathogen
   c. Insect, pathogen, environment
   d. Environment, host, pathogen

3. What are the three stages of incomplete metamorphosis?

   a. Egg, naiad, adult
   b. Egg, pupa, adult
   c. Egg, nymph, adult
   d. Egg, larva, adult

4. Which is an example of an insect that experiences complete metamorphosis?

   a. Aphid
   b. Butterfly
   c. Scale
   d. Silver fish

5. What are the three types of mouth parts an insect may have?

   a. Chewing, sucking, rasping
   b. Rasping-sucking, chewing-sucking, piercing-sucking
   c. Chewing, piercing-sucking, grasping-sucking
   d. Chewing, piercing-sucking, rasping-sucking

6 Which is a pesticide that must be eaten by the insect to be effective?

   a. Contact poison
   b. Fumigant
   c. Stomach poison
   d Systemic poison

7. What classification are pesticides that are made from plant parts?

   a. Inorganic pesticides
   b. Organic pesticides
   c. Synthetic pesticides
   d. Systemic pesticides

Match the following pesticides with the pests they control.

		Type of pesticide		Pests
8.	________	herbicide	a.	fungi diseases
9.	________	fungicide	b.	spiders
10.	________	bactericide	c.	weeds
11.	________	aracicide	d.	rats
			e.	bacterial diseases

Match the following formulations to the proper letters.

12.	_______	dust	a.	no letter
13.	_______	flowables	b.	A
14.	_______	liquified gas	c.	FL or L
15.	_______	soluble powders	d.	D
16.	_______	aerosols	e.	LG
			f.	SP

UNIT V - PESTICIDES

Lesson 2: Interpreting Pesticide Labels

Objective: Students will be able to accurately read and interpret pesticide labels.

Study Questions

1. **What are the three names found on a pesticide label?**
2. **What are the restrictions for the purchase and use of pesticides?**
3. **What are the two degrees of toxicity?**
4. **What are the signal words for the severity of toxicity?**
5. **What additional information can be found on pesticide labels?**

References

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
2. Work Sheet
   a) WS 2.1: Reading a Pesticide Label

UNIT V - PESTICIDES

Lesson 2: Interpreting Pesticide Labels

TEACHING PROCEDURES

A. Review

Review the previous lesson.

B. Motivation

Interpreting a pesticide label correctly is a necessity. It will help reduce accidents and poisonings of humans, animals, and the environment.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students what the two names are for all plants (common name and botanical name).

   What are the three names found on a pesticide label?

   a) Brand or trade name
   b) Common name
   c) Chemical name

2. Ask students if any of them has a driver's or chauffeur's license or a learner's permit. Have them explain the restrictions and use of each.

   What are the restrictions for the purchase and use of pesticides?

   a) General-use pesticides - Anyone can purchase or use these pesticides.

   b) Restricted-use pesticides - These pesticides may only be purchased and used by certified applicators.

3. Ask students to list some household chemicals one might find in a home. Discuss the toxicity of those chemicals.

   What are the two degrees of toxicity?

   a) Acute
   b) Chronic

4. Ask students to list some symbols and signal words they might encounter in their everyday activities (e.g., stop lights, stop signs, "no smoking" signs).

   What are the signal words for the severity of toxicity?

   a) **DANGER** - high toxicity with symbol of skull and crossbones

b) **WARNING** - moderate toxicity
c) **CAUTION** - low toxicity

5. Ask students what kind of information they might find on a cereal box or a package of hot dogs. Have students complete WS 2.1. The instructor will need to provide pesticide containers or photocopies of pesticide labels.

What additional information can be found on pesticide labels?

a) Name and address of manufacturer
b) Active ingredients and net content
c) Type and formulation of pesticide
d) EPA registration and identification number
e) Directions for use
f) Hazard statement
g) Precaution statement
h) Misuse statement (federal law information)
i) Statement of practical treatment
j) Storage and disposal instructions
k) Reentry and safe handling of plant

F. Other Activity

Have students compare various pesticide labels.

G. Conclusion

A pesticide label gives vital information about a particular pesticide. The label information will include, toxicity level, accurate use of the pesticide, and treatment needed if exposure to the pesticide causes harm.

H. Competency

Accurately interpret a pesticide label for information about use, effectiveness, and safe handling.

I. Answers to Evaluation

1. a
2. b
3. c
4. c
5. b

6. Students should include five of the following responses:
Name and address of manufacturer
EPA identification and registration number
Active ingredients
Type of pesticide
Directions for use
Hazard statement
Precaution statement
Misuse statement
Statement of practical treatment
Storage and disposal instructions

Reentry and safe handling of plant

J. Answers to WS 2.1

Answers will be evaluated by instructor dependent upon pesticide labels used.

UNIT V - PESTICIDES

Lesson 2: Interpreting Pesticide Labels

Name ____________________

Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which is not a name of a pesticide found on its label?

   a. Botanical
   b. Brand
   c. Chemical
   d. Common

2. Which pesticide name has a trademark?

   a. Botanical
   b. Brand
   c. Chemical
   d. Common

3. What does the signal word **WARNING** mean?

   a. High toxicity
   b. Low toxicity
   c. Moderate toxicity
   d. Slight toxicity

4. What does the signal word **CAUTION** mean?

   a. One teaspoon to kill an average adult
   b. One tablespoon to kill an average adult
   c. One ounce to one pint to kill an average adult
   d. One pint to one gallon to kill an average adult

5. Which signal word also has the skull and crossbones on the pesticide label?

   a. **CAUTION**
   b. **DANGER**
   c. **PREVENTIVE**
   d. **WARNING**

Complete the following short answer question.

6. What are five additional items of information that may be found on a pesticide label?

   a.
   b.
   c.
   d.
   e.

Lesson 2: Interpreting Pesticide Labels

Work Sheet 2.1: Reading a Pesticide Label

Read a pesticide label to find the correct information.

1. Brand name ____________________
2. Type of formulation ____________________
3. Common name of product ____________________
4. Active ingredients ____________________
5. Signal words ____________________
6. Precautionary statement ____________________
7. Use classification ____________________
8. Misuse statement ____________________
9. Reentry statement ____________________
10. Storage and disposal directions ____________________
11. Net weight ____________________
12. Name and address of manufacturer ____________________
13. Directions for use ____________________
14. Statement of practical treatment ____________________
15. EPA Registration Number ____________________

UNIT V - PESTICIDES

Lesson 3: Using Pesticides Safely

Objective: Students will be able to identify safety precautions that should be followed when mixing, applying, storing, and disposing of pesticides.

Study Questions

1. **What safety precautions should be followed when mixing and applying pesticides?**
2. **What special clothing and equipment are needed when applying pesticides?**
3. **If poisoning occurs, what first aid should be administered?**
4. **What safety precautions should be followed when storing and disposing of pesticides?**

Reference

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.

Lesson 3: Using Pesticides Safely

TEACHING PROCEDURES

A. Review

Review previous lesson.

B. Motivation

Following safety procedures when working with pesticides is a must. Accurate use of pesticides will help prevent the occurrence of poisoning.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students how they might go about baking a cake or barbecuing steaks. What kinds of safety precautions are needed when cooking?

   What safety precautions should be followed when mixing and applying pesticides?

   a) Mixing pesticides
      1) Read label first.
      2) Always wear protective clothing.
      3) Keep pesticides and containers below eye level.
      4) Do not use the same measuring utensils used in food preparation.
      5) Do not mix with other pesticides unless indicated on label.
      6) Mix in well-ventilated area with good lighting.
      7) Never mix stronger than recommended rates.
      8) Mix only amount of pesticide needed.
      9) Measure carefully.

   b) Applying pesticides
      1) Read label first.
      2) Apply only on recommended pests and plants.
      3) Wear protective clothing.
      4) Never smoke or eat when using pesticides.
      5) Direct pesticide only at area to be sprayed.
      6) Do not spray on windy or rainy days.
      7) Do not work alone when using highly toxic pesticides.
      8) Always shower and wash hair and nails. Clean clothing and equipment thoroughly after pesticide application is completed.

2. Ask students what special clothing and equipment a football player or a sky diver might wear.

   What special clothing and equipment are needed when applying pesticides?

   Always read label for required clothing and equipment instructions.

a) Long sleeved shirt
b) Long pants
c) Rubber gloves and boots
d) Wide-brimmed hat
e) Waterproof clothing - raincoat
f) Eye protection - goggles, face shield
g) Respirator

3. Ask student what first aid techniques are used for cuts, broken arms or legs. Ask students if anyone knows what CPR is and how to administer it.

If poisoning occurs, what first aid should be administered?

a) Act as quickly as possible.
b) Without endangering oneself, remove the victim from the contaminated area.
c) Remove contaminated clothing from the victim.
d) Generaously flood the affected skin area or eye with water.
e) Contact the Poison Control Center or a doctor.
f) Administer first aid as indicated by Poison Control Center Personnel or doctor.

NOTE: If a pesticide accident occurs at school, the instructor should notify the school nurse as soon as possible.

4. Ask students how cleansers and detergents are stored in their homes.

What safety precautions should be followed when storing and disposing of pesticides?

a) Storing pesticides
    1) Store in original containers.
    2) Store in locked cabinet or room.
    3) Store in a well-lighted area to allow reading of labels.
    4) Store in an area away from children and animals.
    5) Store in a dry, cool area.
b) Disposing of pesticides and containers
    1) Read and follow pesticide container label for disposal instructions and/or precautions.
    2) Apply any surplus pesticide to other areas with the same pest problem.
    3) Never flush pesticides down the drain, into sewers, or into waterways.
    4) Take unwanted pesticides and/or containers to a toxic waste disposal landfill.
    5) Follow these general guidelines for pesticide disposal as mandated by the U.S. Department of Agriculture and the U.S. Encironmental Protection Agency.
        (a) Never leave surplus pesticides and/or pesticide containers at the application site.
        (b) Never reuse pesticide containters.
        (c) Keep all pesticide containers out of the reach of children.
        (d) Store leftover pesticides in tightly covered containers in a safe storage facility until they can be disposed of safely.
    6) For help with safe disposal of pesticides and/or pesticide containers, contact:

Missouri Department of Natural Resources
Division of Environmental Quality
P.O. Box 176
Jefferson City, Missouri 65102
Business phone: 314-751-7929
Emergency response phone: 314-634-2436

F. Other Activities

1. Have students try on protective clothing and equipment.
2. Have students make a first aid chart.
3. Have students practice first aid procedures.
4. Have an agricultural extension agent come in at end of unit to give certification for pesticide application.

G. Conclusion

Safety is a necessary factor in mixing, applying and storing pesticides. Following safety precautions will help prevent poisoning.

H. Competency

Identify safety precautions that should be followed when using pesticides.

I. Answers to Evaluation

1. b
2. b
3. c
4. a
5. a
6. b

7. List should include five of the following items:
    Long sleeved shirt
    Long pants
    Rubber gloves and boots
    Raincoat
    Wide-brimmed hat
    Goggles or face shield
    Respirator

UNIT V - PESTICIDES

Lesson 3: Using Pesticides Safely

Name ____________________

Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which is not a safety precaution in mixing pesticides?

   a. Read the label before mixing.
   b. Mix more than is needed.
   c. Do not use measuring utensils used in food preparation.
   d. Measure carefully.

2. Which is not a safety precaution for application of pesticides?

   a. Wear protective clothing.
   b. Work alone to prevent poisoning others.
   c. Do not apply on windy days.
   d. Take a shower after application.

3. Which of the following is the most important rule to follow when applying first aid to a pesticide poisoning victim?

   a. Induce vomiting.
   b. Remove contaminated clothing.
   c. Act immediately to begin first aid.
   d. Check for shock symptoms.

4. If poison gets into the eyes, what type of first aid should be administered?

   a. Flush with clean water.
   b. Open all doors and windows so victim can have light.
   c. Wrap victim in a blanket.
   d. Wash victim's skin.

5. Where should pesticides not be stored?

   a. In other containers
   b. In a cool, dry place
   c. In a locked cabinet
   d. Away from children

6. What safety information is not found on a pesticide label?

   a. Protective clothing to be worn during application
   b. Doctor's phone number should poisoning occur
   c. First aid suggestions
   d. Proper disposal of the pesticide container

Complete the following short answer question.

7. What are five articles of special clothing or equipment to use for safety when applying pesticides?

   a.
   b.
   c.
   d.
   e.

UNIT VI - INSTALLATION AND MAINTENANCE OF TREES AND SHRUBS

Lesson 1: Installing Trees and Shrubs

Objective: The student will be able to describe procedures for planting and transplanting balled and burlapped, container-grown, and bare-root trees and shrubs.

Study Questions

1. **How are trees and shrubs sold?**
2. **How should the soil be prepared before planting trees and shrubs?**
3. **How are trees and shrubs transplanted?**
4. **What procedures should be followed when planting bare-root, balled and burlapped, and container-grown plants?**
5. **What types of mulches can be used around trees and shrubs?**

References

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Material Laboratory, 1990.
2. Job Sheets

a)	JS 1.1:	Transplanting a Tree or Shrub
b)	JS 1.2:	Planting Bare-Root Trees or Shrubs
c)	JS 1.3:	Planting Container-Grown Trees or Shrubs
d)	JS 1.4:	Planting Balled and Burlapped Trees or Shrubs

UNIT VI - INSTALLATION AND MAINTENANCE OF TREES AND SHRUBS

Lesson 1: Installing Trees and Shrubs

TEACHING PROCEDURES

A. Introduction

Ask the students if they or their parents have purchased any plants from the nursery lately. If so, ask them how the roots were confined. Were they bare, in a container with soil, or covered with burlap? Point out that each of these have advantages and that they have to weigh these before they choose a form to plant.

B. Motivation

The life or death of a tree or shrub depends partly on using high quality plant material. However, even with high quality plant material, unless it is transplanted by the proper procedures, an expensive tree or shrub will be more likely to die.

C. Assignment

D. Supervised study

E. Discussion

1. During the discussion, it would be helpful to show examples of how trees and shrubs are sold.

How are trees and shrubs sold?

a) Bare-root
    1) Advantages
        (a) Least expensive
        (b) Light weight and easy to transplant
        (c) Should be dormant when transplanted in winter and early spring
        (d) Can use unamended back-fill
    2) Disadvantages
        (a) Reduced root system
        (b) Small plants needing long time to mature
        (c) Transplant season limited to winter and early spring
b) Balled and burlapped (B and B)
    1) Advantages
        (a) Larger plants can be planted
        (b) Less damage to root system
        (c) Planted throughout early spring to late fall
        (d) Planted in winter as long as ground is not frozen
    2) Disadvantages
        (a) Usually more expensive
        (b) Soil ball adds extra weight and bulk
        (c) Larger plants expensive to install, require heavy equipment
c) Container-grown plants
    1) Advantages
        (a) Less expensive than B and B, yet have a rootball
        (b) Can be planted through spring, summer, and fall

        2) Disadvantage of becoming root bound if left in container too long

2. Ask if the students have planted or helped plant any trees or shrubs. Ask if they added anything to the soil before they planted the tree. Point out that this is a very important step, and if the proper items are not added to the soil when planting, the tree or shrub could die. Have the students prepare the planting hole for a tree.

How should the soil be prepared before planting trees and shrubs?

a) Assess the soil.
    1) Texture
    2) Structure
    3) Depth
    4) Compaction
    5) Soil test
b) Add recommended materials to the back-fill soil.
    1) Slow release form of fertilizer (in tablets)
    2) Not a high analysis form of fertilizer
c) Test for drainage and aeration.
    1) Fill planting hole with water.
    2) If water drains out in 18-24 hours; it is satisfactory.
    3) If not, choose water-tolerant plants or install drainage tiles.
d) If a plow-pan soil:
    1) Planting hole must be below plow pan.
    2) Fill with soil from below the plow-pan zone plus organic matter.
e) If shallow:
    1) Make raised beds.
    2) Drill below the plow-pan zone; fill with surface soil plus organic matter.
    3) Add nitrogen to organic material.

3. Spring and fall are busy times in the nursery business, since these are the best times to plant trees and shrubs. At these times, the plants are dormant or semi-dormant. For the most success, a tree should be planted when the leaves are not actively growing. This reduces the stress on the tree and allows the roots to get well established. Have the students complete JS 1.1 Transplanting a Tree. Obtain permission for the class to dig a tree from the field of a local nursery. If this is not feasible, dig a tree from the school grounds. Avoid large trees. A one to two inch caliper is satisfactory.

How are trees and shrubs transplanted?

a) Time
    1) Best time is when plant is dormant or semi-dormant.
    2) If plant is in leaf, keep leaves cool and shaded.
    3) Choose a time when root growth exceeds top growth.
        (a) Early autumn
        (b) Early spring
b) Preparation
    1) Soil should not be too wet or dry to keep rootball together.
    2) Larger trees can be root pruned ahead of time, several months to a year, if possible, to encourage a more vigorous root system.
c) Digging
    1) Use a sharp spade.
    2) Dig a circle 12" in diameter per inch of trunk diameter.
    3) Dig as deep as wide.

        4) Shape ball in a spherical shape; leave on a pedestal of soil.
        5) Tip soil ball off pedestal; cut roots still attached.
        6) Bring burlap under ball; pull tightly and secure with nails, used as pins.
        7) Wrap the ball completely, securing the burlap with the pinning nails.
        8) Bind top with cord, going around the ball for support.
    d) Removing from hole
        1) Lift the tree out of the hole by using the soil ball and the cords.
        2) Do not use trunk as a handle.

4. Following the proper procedure when planting a tree or shrub will help ensure the success of the tree or shrub. There are different procedures to follow for each bare-root, container-grown, and B and B plant. Demonstrate the procedures listed in Job Sheets 1.2 - 1.4. Then have the students complete Job Sheets 1.2 - 1.4. If all of the plant material is not available, omit as necessary.

What procedures should be followed when planting bare-root, balled and burlapped, and container-grown plants?

a) Prepare the planting hole.
    1) Bare-root plants - large enough not to cramp or bend roots
    2) Balled and burlapped and container-grown plants
        (a) Six inches wider than the container or ball width on all sides.
        (b) Glazed sides roughened
    3) Four to six inch mound of soil left in bottom of hole for bare-root plants.
b) Decide on the orientation of the plant.
    1) Windy conditions
        (a) Side with most branches into wind
        (b) Bare-root - largest root into the wind
    2) Non-windy conditions
        (a) Most pleasing side to the most viewed area
        (b) Side with lowest branches away from activity area
        (c) Side with highest branches on side of activity
c) Plant bare-root plant.
    1) Prepare the roots.
        (a) Soak in water overnight.
        (b) Prune back twisted, broken, or diseased roots.
    2) Spread roots over mound of soil.
    3) Set stakes, if needed.
    4) Fill hole three-fourths full (can use original soil).
    5) Firm in the soil.
    6) Water thoroughly.
    7) If it settles, below crown or original soil line, rock trunk back and forth while pulling up.
    8) Finish filling hole with soil.
    9) Adjust depth while filling.
    10) Make a berm (dish):
        (a) Twice the diameter of rootball.
        (b) Four to six inches high around outside.
        (c) Six inches away from trunk.
    11) Water again.
    12) Add mulch.
d) Plant balled and burlapped plant.
    1) Set soil ball at original soil level.
    2) Untie and remove string securing burlap around trunk.

        3) Spread burlap open.
        4) Fill hole with prepared back-fill one half full.
        5) Firm soil around rootball.
        6) Stake if necessary.
        7) Fill in remainder of soil.
        8) Cut away excess burlap.
        9) Build a berm (dish).
        10) Water thoroughly.
        11) Add mulch.
    e) Plant container-grown plant.
        1) Remove from container.
            (a) Turn plastic pots over.
            (b) Cut sides of metal cans.
            (c) Tear top of fiber pots below soil level.
        2) Loosen or cut circling roots.
        3) Make several, shallow, vertical cuts in the sides of the rootball.
        4) Place rootball on mound of soil.
        5) Fill hole one half full with back-fill.
        6) Firm soil in around roots.
        7) Stake if necessary.
        8) Finish filling hole, firming in the process.
        9) Make a berm (dish).
        10) Water thoroughly.
        11) Add mulch.

5. Newly-planted trees and shrubs benefit greatly when a mulch is applied to the surface of the planting area. The roots are not developed fully yet so they are unable to handle stress due to lack of water.

What types of mulches can be used around trees and shrubs?

a) Purposes of mulch
    1) Retains water
    2) Keeps weeds down
    3) Has attractive appearance
    4) Stabilizes temperatures
b) Characteristics
    1) Must be two to four inches thick to keep weeds down
    2) Black plastic used under a thin mulch
        (a) Keeps weeds down
        (b) Causes water logging
        (c) Does not allow oxygen to reach roots
        (d) Should be cut to allow oxygen and air to reach plants
    3) Landscape fabric, a weed barrier mat
        (a) Keeps weeds down
        (b) Allows water and air to pass through
        (c) Does not waterlog plants
c) Choices of mulch
    1) Organic
        (a) Wood chips
        (b) Shredded bark
        (c) Lawn clippings
        (d) Pine needles

2) Inorganic
   - (a) Crushed stone
   - (b) Marble chips
   - (c) Brick chips
   - (d) River rock

F. Other activities

1. Acquire one or more bare-root, B and B, or container-grown plants (could be a donation or purchase from a local nursery). A field trip to select these plants at the nursery would be good, if possible. If this is not feasible, there might be plants on the school property that could be used.

2. Have students dig a tree or shrub, prepare the planting hole, and plant the tree or shrub following the procedures explained in the unit.

3. If possible, have students take a soil test. Have them prepare the planting hole at least two or three days ahead so it can be filled with water and drained to check for drainage.

4. Demonstrate how to dig a tree and cover the ball with burlap. Demonstrate how to plant a bare-root, container-grown, and B and B tree or shrub.

G. Conclusion

Trees and shrubs must be planted according to the proper procedure for different types of root systems. Learning the proper planting procedure is essential for a successful future in the landscape installation business.

H. Competency

Transplant a tree or shrub and properly plant a bare-root, container-grown, or B and B tree or shrub.

I. Answers to Evaluation

1. c
2. c
3. a
4. a
5. a
6. d
7. a
8. b
9. a
10. b
11. b
12. c
13. b
14. a
15. d

UNIT VI - INSTALLATION AN MAINTENANCE OF TREES AND SHRUBS Name ____________________

Lesson 1: Installing Trees and Shrubs Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. What type of hole should be used when planting bare-root plants?

   a. A post hole
   b. A shallow trench
   c. A hole large enough not to cramp roots
   d. A hole deeper than it is wide

2. Where is the best place to grasp a B and B tree?

   a. By the rope
   b. By the small branches
   c. By the soil ball
   d. By the trunk

3. What depth should the hole be when planting a B and B tree?

   a. The same depth as the rootball
   b. Four to five inches deeper than the rootball
   c. Three times the size of the rootball
   d. Twice the size of the rootball

4. What should be mixed with soil when planting trees and shrubs in compacted soil?

   a. Nothing
   b. Sand
   c. Sawdust
   d. Strong fertilizer

5. When is best time of year to plant trees and shrubs?

   a. Early fall
   b. Late spring
   c. Mid-summer
   d. Mid-winter

6. What should be done to plastic when used under a mulch?

   a. Cut it so that the weed barrier touches the plant.
   b. Layer it under the roots.
   c. Cover the plant with it.
   d. Cut it to allow air and water to get to roots.

7. Which is an inorganic mulch?

    a. Crushed stone
    b. Lawn clippings
    c. Pine needles
    d. Shredded bark

8. How large a rootball should be dug for a B and B tree with a trunk of one inch in diameter?

    a. 6 inches in diameter
    b. 12 inches in diameter
    c. 24 inches in diameter
    d. 36 inches in diameter

9. What type of fertilizer should not be used when planting trees or shrubs?

    a. High analysis granular
    b. Liquid
    c. Slow-release
    d. Water-soluble

10. What is advantage of planting a B and B tree as opposed to a bare-root tree?

    a. It is the least expensive type of tree.
    b. Larger plants can be planted.
    c. They can be planted when dormant in the early spring.
    d. They have a reduced root system that is easier to plant.

11. What should the ball be set on in the bottom of the hole when planting a B and B tree?

    a. A mound of loose soil
    b. A flat surface at the bottom of the hole
    c. A flat surface of gravel
    d. A flat surface covered with some loose soil

12. When planting a bare-root tree, when should it be watered?

    a. Four hours after the tree is planted
    b. When the hole is half full
    c. When the hole is half full, and again when it is full
    d. After the tree is placed on the mound of soil

13. Which is the best procedure for making a berm?

    a. Make it four to six inches high by the trunk of the tree.
    b. Make it four to six inches high at the outer edge of the planting hole.
    c. Make it two inches high at the outer edge of the planting hole.
    d. Make it twelve inches high by the trunk of the tree.

14. What should be done with exposed burlap?

   a. It should be removed.
   b. It should be left on to protect the roots.
   c. It should be left on to maintain wick action.
   d. It should be left on to keep soil ball warm.

15. What should be done with the cord around a B and B tree when the tree is planted?

   a. It should be kept on to hold the ball securely.
   b. It should be removed along with the burlap.
   c. It should be kept on for three weeks.
   d. It should be removed so it does not girdle the roots.

Lesson 1: Installing Trees and Shrubs

Job Sheet 1.1: Transplanting a Tree or Shrub

Objective: Upon completion of this job sheet, the student will be able to transplant trees and shrubs.

Materials and Supplies Needed:

1. Sharp spade
2. Burlap
3. Twine or cord
4. Nails (Use as pins)

Procedure:

1. Using a sharp spade dig a circle around the tree. The diameter of the soil ball should be 12 inches per inch of caliper (diameter of the trunk).

2. Dig the hole as deep as wide.

3. Shape the ball in a spherical shape while digging. Leave on a pedestal of soil.

4. Prune any large, protruding roots.

5. Tip the ball off the pedestal, and cut any roots still attached.

6. Bring the burlap under the ball.

7. Pull burlap tightly, and secure using nails as pins, wrapping the entire ball.

8. Bind the top with twine or cord, wrapping it around the ball.

9. Remove the tree from the hole by lifting the soil ball.

   Note: Do not use the trunk as a handle.

Lesson 1: Installing Trees and Shrubs

Job Sheet 1.2: Planting Bare-Root Trees or Shrubs

Objective: Upon completion of this job sheet, the student will be able to plant bare-root trees or shrubs.

Materials and Supplies Needed:

1. Spade
2. Bare-root plant material
3. Soil amendments, fertilizer (based on previous soil test)
4. Staking or guying materials (See Job Sheets 2.1 and 2.2 for instructions on staking and guying).

Procedures:

1. Prepare the roots by soaking them in water overnight if dry, and pruning any dead or twisted roots.
2. Dig a hole just large enough so the roots can be spread out and not cramped.
3. The hole should be four to six inches deeper than needed; then a mound of soil should be placed back in the hole in a cone shape.
4. Decide the orientation of the tree.
5. Place the roots spread out over the mound of soil.
6. Stake if necessary.
7. Fill the hole three-fourths full with soil.
8. Tamp the soil in around the roots to avoid air pockets. Note: Can use original soil.
9. Water thoroughly.
10. If the tree settles too low, below the crown or the original soil line, gently rock the tree back and forth while pulling up. Note: Do not try this on container-grown or B and B trees.
11. Finish filling in the soil and adjust the depth in the process.
12. Make a berm around the tree to hold water. It should be two times the diameter of the rootball, four to six inches high around the outside and six inches away from the trunk.
13. Water again.
14. Add mulch.

Lesson 1: Installing Trees and Shrubs

Job Sheet 1.3: Planting Container-Grown Trees or Shrubs

Objective: Upon completion of this job sheet the student will be able to plant container-grown trees or shrubs.

Materials and Supplies Needed:

1. Spade
2. Container-grown tree or shrub
3. Soil amendments, fertilizer (based on previous soil test)
4. Staking and guying materials (See Lesson 2, Job Sheets 2.1 and 2.2 for instructions on staking and guying).

Procedures:

1. Be sure the plant material is well-watered.
2. Prepare the planting hole by digging two times the container width and the same depth as the container depth.
3. Be sure the sides of the hole are straight down or flared out.
4. Roughen glazed sides.
5. Determine the orientation of the tree or shrub.
6. Remove the plant from the container (follow description in student reference).
7. Loosen or cut circling roots. Make several shallow vertical cuts on the sides of the rootball.
8. Place the tree or shrub in the hole. The rootball should be at the soil level.
9. Fill the hole one-half full with back-fill.
10. Firm the soil in around the roots.
11. Stake if necessary.
12. Finish filling in the hole firming the soil in the process.
13. Make a berm (dish) four to six inches high around the outside edge of the planting hole.
14. Water thoroughly.
15. Add mulch.

Lesson 1: Installing Trees and Shrubs

Job Sheet 1.4: Planting Balled and Burlapped Trees or Shrubs

Objective: Upon completion of this job sheet the student will be able to plant B and B trees or shrubs.

Materials and Supplies Needed:

1. Spade
2. B and B plant material
3. Soil amendments, fertilizer (as determined in previous soil list)
4. Stakes, cord, and protective covering
5. Guying wire stakes, flags, and protective covering (See Lesson 2, Job Sheets 2.1 and 2.2 for instructions on staking and guying).

Procedures:

1. Be sure the plant material is adequately watered. B and B plants should not be soaked before planting or else the ball will fall apart.
2. Prepare the planting hole by digging the hole six inches wider than the ball width on all sides and the ball depth. Be sure the sides are straight down or flared out.
3. Roughen glazed sides.
4. Place the root ball in the center of the hole.
5. Untie or cut the string wrapped around the burlap surrounding the trunk.
6. Spread burlap open.
7. Fill in the hole with back-fill one-half full.
8. Firm the soil around the ball.
9. Stake, if necessary.
10. Fill in remainder of soil.
11. Cut away any excess burlap.
12. Build a berm (dish). It should be four to six inches high and at the outside edge of the planting hole.
13. Water thoroughly.
14. Add mulch.

UNIT VI - INSTALLATION AND MAINTENANCE OF TREES AND SHRUBS

Lesson 2: Post-Transplant Care

Objective: The student will be able to describe procedures to care for newly-transplanted trees and shrubs.

Study Questions

1. **When and how is staking and guying used?**
2. **Why and how are trees wrapped and when should wrapping be removed?**
3. **What are the purposes of using anti-transpirants?**
4. **Why are plants pruned or not pruned after being transplanted?**

References

1. Landscaping and Turf Management. (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
2. Job Sheets

a)	JS 2.1:	Staking a Tree
b)	JS 2.2:	Guying a Tree
c)	JS 2.3:	Wrapping a Tree

Lesson 2: Post-Transplant Care

TEACHING PROCEDURES

A. Review

Review the previous lesson.

B. Motivation

Homeowners spend a lot of money on trees, and the landscaper invests time planting the tree. Post-transplant care could mean the life or death of this investment and should always be practiced with caution.

C. Assignment

D. Supervised study

E. Discussion

1. Like young children, young trees are not always able to stand on their own. Ask the students what they would do to help a young tree until it gets established. Have students complete Job Sheets 2.1 and 2.2.

When and how is staking and guying used?

a) Causes of weakness in trees:
    1) Staked and protected from wind and weather when young
    2) Grown too close together in the nursery
    3) Lower branches removed
b) Staking is used for:
    1) Anchorage of roots until they are established
    2) Protection from injury
    3) Support
        (a) If tree is too weak to stand alone
        (b) To secure roots
        (c) For smaller trees up to 1 1/2" in diameter, the one-stake or slant method will work fine.
        (d) With trees from 1 1/2" in diameter, the two- or three-stake methods work fine.
        (e) Larger trees should be guyed. When guying trees, use turnbuckles to keep the wires snug and use hazard markers to prevent people from tripping over the wires.
        (f) Staking guidelines
            (1) Stakes should be 18" deep and no higher than two-thirds height of tree
            (2) Placed parallel to the trunk, unless using the slant method
            (3) Ties looped around trunk and attached to stake two inches from top
            (4) Crosstie placed at or below soil line
c) Guying is used for:
    1) Same reasons as staking: greater support

        2) Trees greater than three inches in diameter
            (a) Three or four guy wires with compression springs or turnbuckles attached to a protective collar around tree trunk
            (b) Ends of wires attached to stakes in the ground
            (c) Stakes angled away from tree
            (d) Flags of reflective material for visibility
            (e) Guy wires at 45° angle with trunk and ground
    d) Precautions for staking and guying
        1) Flexible material around tree
            (a) Should not rub bark away
            (b) Should not girdle tree
        2) Wire covered by rubber hose, or other protective covering
        3) Two stakes, not one, to prevent unnecessary rubbing
        4) Same holes for later, replacement stakes
        5) Staking and wiring only when necessary

2. An added protection for trees is wrapping. A paper, tree-wrap is most commonly used. Ask the students if they have ever used a tree-wrap. Have a sample to show students. Demonstrate how to wrap a tree with the paper, tree-wrap available at a local nursery. Have the students take turns trying it. Have the students complete Job Sheet 2.3.

Why and how are trees wrapped and when should wrapping be removed?

a) Trunk protection from:
    1) Sunburn
    2) Sun scald - winter injury
    3) Water loss
    4) Animal damage
    5) Weed trimmer damage
b) Materials used:
    1) Paper or burlap
    2) Latex paint
    3) Tree wrapping paper - used most often
        (a) Wrapped from the ground up
        (b) Overlapped one-half the width of the paper
        (c) Fastened with rope or electrical tape
c) Wrapping removed when it disintegrates or after one year

3. Ask the students to tell what they think an anti-transpirant does. Point out that these can be used when moving or planting trees in mid-summer, or when the temperatures are very hot. However, caution should be taken not to apply too much or too often. If the situation warrants, demonstrate the application of an anti-transpirant.

What are the purposes of using anti-transpirants?

a) Purposes
    1) To cut down on moisture loss after a tree is transplanted
    2) To preserve moisture in plant during drought
    3) To prevent winter burn of evergreens in cold, dry winters
b) Kinds
    1) Chemical to reflect light
    2) Wax, plastic, or latex spray to block stomata - used most often (such as Wilt Proof™)
    3) Chemical to prevent stomata opening

    c) Can be toxic - should be used with caution

4. Explain to students that reduction in roots caused by transplanting will require a reduction in top growth. Otherwise, there are not enough roots to support the plant. Pruning of young trees will be discussed in Lesson 3.

   Why are plants pruned or not pruned after transplanting?

    a) Reduces leaf surface area to balance root loss
    b) Not necessary if irrigation is adequate
    c) Better not to prune although sometimes necessary; not necessary if plant has been recently pruned at nursery
    d) Alternatives to reducing size of plant
        1) Thinning out crossing branches
        2) Removing broken branches
        3) Correcting undesirable branching
        4) Pruning fruit trees to promote low branch growth

F. Other Activities

1. Stake a tree which is newly-transplanted.

2. Put guy wires on a tree.

3. Practice wrapping a tree.

4. Apply an anti-transpirant, if available.

5. Prune a newly-transplanted tree.

G. Conclusion

Although post-transplant care is essential for the health of a plant, it should be done with caution so the health of the newly-transplanted plant is not threatened.

H. Competency

Stake and guy a newly-planted tree; wrap, prune, and apply anti-transpirants to a young tree.

I. Answers to Evaluation

1. a
2. c
3. d
4. b
5. a
6. d
7. d
8. c
9. c
10. d
11. b

UNIT VI - INSTALLATION AND MAINTENANCE OF TREES AND SHRUBS

Lesson 2: Post-Transplant Care

Name ____________________

Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. When staking a tree, what is characteristic of a girdled trunk?

    a. Has been tied too tightly
    b. Is below the top of the stake
    c. Needs to be wrapped tighter
    d. Provides support for the plant

2. Why is staking done?

    a. To protect the bark of the tree
    b. To support trees of six inches diameter and above
    c. To anchor the roots until they are established
    d. To reduce the leaf portion to be in balance with the roots

3. What should be considered when staking or guying a tree?

    a. The tree should be anchored tightly enough that it cannot move.
    b. The rootball should move but the branches should not.
    c. The rootball should be the only part that does not move.
    d. The tree should be able to bend slightly when the wind blows.

4. What degree should the angle of the wires to the ground be when guying a tree?

    a. 15°
    b. 45°
    c. 65°
    d. 90°

5. When guying a tree, where should the stakes in the ground be?

    a. Angled away from the tree
    b. Angled towards the tree
    c. Straight up
    d. At right angles to the tree

6. Where should the protective collar be placed, when guying a tree?

    a. Below the third set of branches
    b. Above the second set of branches
    c. Below the first set of branches
    d. Above the first set of branches

7. How tall should stakes be for staking a tree?

   a. As tall as the tree
   b. One-third the height of the tree
   c. One-half the height of the tree
   d. Two-thirds the height of the tree

8. Where should a tree-wrap begin on a tree?

   a. At the top of the tree trunk
   b. Below the first set of branches
   c. At the bottom of the tree trunk
   d. At the midpoint of the tree trunk

9. When should paper wrapping be removed from a tree?

   a. After one month
   b. After six months
   c. After one year
   d. Never

10. How often should anti-transpirants be used?

    a. Every week
    b. Every month
    c. Every year
    d. Only when necessary if moving trees in hot weather or during a drought

11. What pruning procedure should be taken after a tree is transplanted?

    a. Always prune.
    b. Prune if it was not recently pruned in the nursery.
    c. Never prune.
    d. Prune one-half of its top growth.

Lesson 2: Post-Transplant Care

Job Sheet 2.1: Staking a Tree

Objective: Upon completion of this job sheet, the student will be able to stake young trees.

Note: This job sheet should be done in conjunction with Unit VI, Lesson 1, Job Sheets 1.2 through 1.4.

Materials and Supplies Needed:

1. Two - 2" x 2" stakes - (The length depends on the size of the tree. They should be 18" deep in the ground, and no higher than two-thirds the height of the tree.)
2. Wires in protective covering (garden hose pieces)
3. Hammer

Procedure:

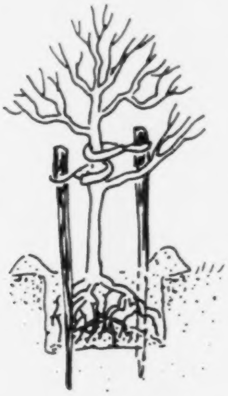
1. When the planting hole is half full of soil, drive in the stakes into the undisturbed soil beneath the rootball, and parallel to the tree trunk.

   NOTE: A tree already growing may also be used.

2. Fill in the remainder of soil.

   Note: If stakes are inserted after the tree is planted, avoid sticking the stakes through the rootball.

3. Loop the wires around the tree trunk and attach them to the stakes within two inches of the top of the stake.



Lesson 2: Post-Transplant Care

Job Sheet 2.2: Guying a Tree

Objective: Upon completion of this job sheet the student will be able to guy wire a tree.

Materials and Supplies Needed:

1. Guy wires
2. 3-4 compression springs (or turnbuckles)
3. Reinforced material or rubber hose for trunk protection
4. 3-4 pins with looped ends
5. 3-4 six- to eight-inch stakes
6. Reflective flags

Note: A tree guying kit can be purchased instead of obtaining individual supplies.

Procedure:

1. Attach wire with protective covering around the tree trunk just above the first set of branches.

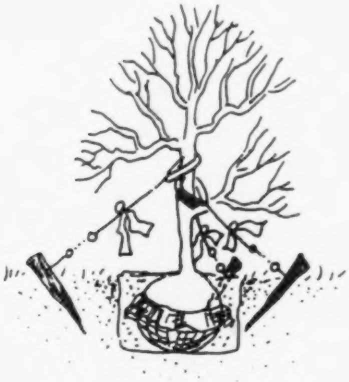
2. Attach pins to the ends of the wires.

3. Stretch the wires so they form a 45° angle from the trunk of the tree to the ground in order to measure for the location of the stakes.

4. Insert stakes in the ground seven inches deep angling away from the tree. Be sure they are low enough not to interfere with mowing.

5. If turnbuckles are used, tighten them snugly.

6. Tie reflective flags midway up the wire.



Lesson 2: Post-Transplant Care

Job Sheet 2.3: Wrapping a Tree

Objective: Upon completion of this job sheet, the student will be able to wrap a tree.

Materials and Supplies Needed:

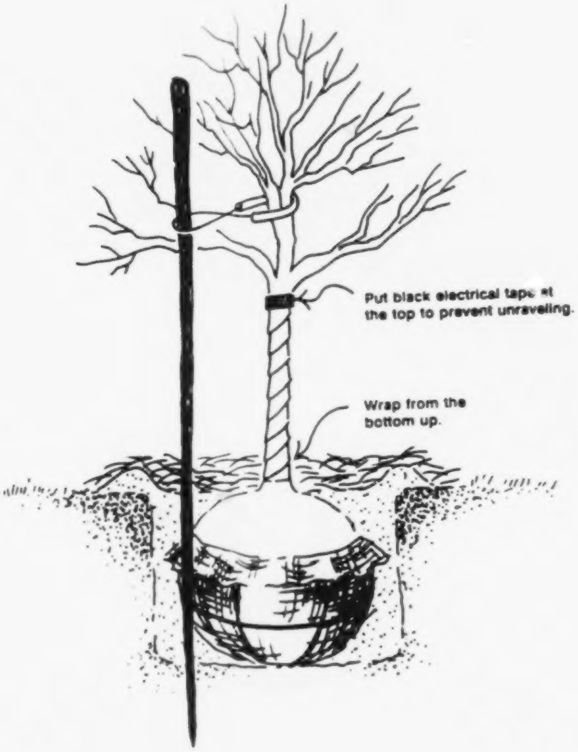
1. A tree to wrap
2. Tree wrap
3. Twine or electrical tape

Procedure:

1. Beginning at the base of the trunk at ground level, spiral the wrap upward overlapping about one-half the width of the material.

2. Wrap to the first limb.

3. Fasten the wrap at the first limb by spiralling twine around the trunk in the opposite direction, or securing it with electrical tape.


Put black electrical tape at the top to prevent unraveling.
Wrap from the bottom up.

UNIT VI - INSTALLATION AND MAINTENANCE OF TREES AND SHRUBS

Lesson 3: Pruning

Objective: The student will be able to prune evergreens, deciduous trees, shrubs, hedges, and roses.

Study Questions

1. **What are the purposes of pruning?**
2. **What are the plant's responses to pruning?**
3. **How do the two types of pruning cuts affect the appearance and determine the growth habit of plants?**
4. **What are the proper procedures for pruning branches?**
5. **How do pruning procedures differ when pruning evergreen trees, deciduous trees, flowering shrubs, and hedges?**
6. **What are the pruning procedures for roses?**

References

1. Landscaping and Turf Management. (Student Reference) University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
2. Work Sheet
    - a) WS 3.1: Pruning Cuts
3. Job Sheet
    - a) JS 3.1: Making Pruning Cuts

UNIT VI - INSTALLATION AND MAINTENANCE OF TREES AND SHRUBS

Lesson 3: Pruning

TEACHING PROCEDURES

A. Review

Review the previous lesson.

B. Motivation

Pruning should begin just after the proper plant is selected for a site and it has been carefully planted. The first few years of a tree's life is indicative of the health of the tree. Proper pruning when a tree is young will help ensure a healthy tree when it is mature.

C. Assignment

D. Supervised study

E. Discussion

1. When a tree is in the forest in its natural surroundings, nature has ways to groom and protect the tree. A tree's neighbors help protect it from strong wind, prune its lower branches, and help it form a shapely crown. When a tree is planted in an open lawn, it must fend for itself unless it is helped by pruning.

What are the purposes of pruning?

a) Increases survival rate when planting
b) Alters size and shape of tree
c) Corrects undesirable growth
    1) Crossing branches
    2) Weak, narrow, crotches
    3) Multiple leaders
    4) Water sprouts
d) Removes low-hanging branches or ones that interfere with traffic
e) Reduces heavy fruit load
f) Reduces size of the plant
g) Invigorates new growth
h) Removes old, weak, wood; broken or dying branches caused by
    1) Excess shading
    2) Insects
    3) Diseases
    4) Mechanical Injury
    5) Lightening injury
    6) Air pollution
    7) Root damage caused by
        (a) Improper fertilization
        (b) Drought
        (c) Excess water
        (d) Poor soil aeration
        (e) Soil pollution

        (f) Insects and diseases

2. Pruning creates one of three responses: dwarfing, invigoration, or change in growth habit. Ask the students to try to explain why a tree pruned early in the season shortly looks three times as big as it was.

   What are the plant's responses to pruning?

   a) Dwarfing - overall size is reduced
   b) Invigoration - more nitrogen supplied to fewer branches and leaves
   c) Change in growth habit
      1) Apical dominance changed by pruning, causing lateral branches to grow
      2) Desirable in shrubs and hedges; not conifers and some deciduous trees

3. Try to get the students to understand the difference between "heading back" and "thinning out". "Thinning out" implies the branch is being completely taken out and in "heading back" is simply being trimmed back. Have students complete WS 3.1.

   How do the two types of pruning cuts affect the appearance and determine the growth habit of plants.

   a) "Heading back" - cuts back part of the branch or limb
      1) Light cut
         (a) Stimulates buds near cut
         (b) Grows the direction the bud faces
      2) Heavy cutting - latent or buds further down are stimulated
      3) Creates a bushier, fuller looking plant
      4) Shearing - removes only tips of stem
         (a) Hedges
         (b) Formal look
         (c) Dense foliage at outer extreme; bare on inside
   b) "Thinning out" - removes entire shoot or branch
      1) Can remove a branch back to another branch
      2) Can remove entire shoot down to the ground
      3) Can create a more open, simplified look

4. Emphasize to the students that making an improper pruning cut can be more detrimental to a tree or shrub than not making a cut at all. An improper cut may take longer to heal, thus allowing greater susceptibility to pests and diseases. Have students complete JS 3.1. The instructor should demonstrate the procedure first.

   What are the proper procedures for pruning branches?

   a) Pruning cut
      1) Cut one-fourth inch above the bud at a 45° angle.
      2) Use pruning shears.
      3) Never leave a stub.
   c) Smaller branches
      1) Use pruning shears or lopping shears.
      2) Place blade against the tree with hook to the outside.
      3) Cut flush with main trunk.
      4) Use a pruning saw for tight spaces.
         (a) Make the first cut on the underside.
         (b) Make the second cut on the upper side, making the cuts meet.

- d) Larger limbs
  - 1) Use a pruning saw.
  - 2) Make a three-part cut.
    - (a) Cut half way through the under side of the limb, three to four inches out.
    - (b) Cut half way through the upper side of the limb, three to four inches out from the first cut.
    - (c) With the third cut, remove most of the stub. Make the cut outside the wrinkled bark, which is the callus layer, on the upper side.
  - 3) Use sharp pruning shears when shearing hedges.
  - 4) Dress wounds over one and one-half inches wide with tree paint immediately after wound is made.

5. Point out to the students that each different type of tree or shrub has individual pruning requirements. They must know the flowering process of shrubs or else they might remove the flowering buds for the next season. A client will not be happy if this is done.

How do pruning procedures differ when pruning evergreen trees, deciduous trees, flowering shrubs, and hedges?

- a) Evergreen plants
  - 1) Whorl-branching (pine, fir, spruce, hemlock)
    - (a) Prune back to a lateral branch or a bud.
    - (b) On pines, pinch back candles to promote closer whorls.
    - (c) On spruces, cut half of the terminal shoot to close open spaces.
    - (d) Avoid damage to central leader or train a lateral to replace it if this happens.
    - (e) Never cut back to bare wood.
  - 2) Random - branching (juniper, yew, arborvitae)
    - (a) Prune almost anytime with severe pruning in April.
    - (b) Cut back long branches to a junction with a lateral.
    - (c) Prune in early spring.
    - (d) Make cuts "back in."
    - (e) Do not cut back junipers and arborvitae to bare wood.
    - (f) Yews can be cut back to an almost bare stub.
- b) Very young deciduous trees
  - 1) Pruning
    - (a) Determine the use of a tree in a landscape.
    - (b) Direct its growth habit.
    - (c) Correct structural weakness.
  - 2) Choose scaffold branches.
  - 3) Leave temporary branches on until caliper is two to three inches.
  - 4) Prune to regain central leader.
- c) Young to medium-age deciduous trees
  - 1) Remove branches with angles narrower than 45°.
  - 2) Choose scaffold branches.
    - (a) Leave branches 18 - 24 inches apart.
    - (b) Choose those spaced as well as possible around trunk.
    - (c) Leave more than needed the first year, and choose the strongest the second year.
  - 3) Choose well-placed branches.
  - 4) "Head back" branches that are larger than the one to which they are attached.
- d) Mature trees
  - 1) Not much pruning is needed, if well-maintained when younger.
  - 2) Do maintenance pruning; removing broken, dead, diseased, and crossing

    branches.
  - 3) Thin, to open canopy.
  - 4) Topping, heading, or stubbing should be done only when absolutely necessary.
  - 5) Pruning large trees is dangerous without proper equipment.
- e) Ornamental deciduous trees
  - 1) They can be pruned throughout the whole year.
  - 2) Early spring is best for pruning.
    - (a) One can see all the branches.
    - (b) Buds are swelling.
  - 3) Summer pruning is sometimes done.
    - (a) It is a landscaper's slow time.
    - (b) One may not see all the branches through the leaves.
  - 4) Fall pruning may leave a tree susceptible to winter injury.
  - 5) Winter pruning is sometimes done.
    - (a) It is a landscaper's slow time.
    - (b) Winter injury is possible.
- f) Shrubs
  - 1) Spring, flowering shrubs bloom from buds produced the previous season.
    - (a) Prune immediately after flowering.
    - (b) Remove weak growth; broken, diseased, and crossing branches first; using pruning shears.
    - (c) Remove older canes as needed; one-third to one-fourth of the canes each year, using lopping shears.
    - (d) Some shrubs bloom on wood older than one year old, so never prune excessively.
  - 2) Summer, flowering shrubs bloom from buds produced the current season.
    - (a) Prune anytime before growth starts in the spring.
    - (b) Prune with same methods as spring, flowering shrubs.
- g) Hedges
  - 1) Prune often to keep in shape; anytime during the year.
  - 2) Prune wider at the base than the top.
  - 3) Hedges can be sheared but heading back looks more natural and informal.

6. Point out to students that roses require special pruning procedures according to climate and type of rose.

What are the pruning procedures for roses?

- a) Newly-established
  - 1) Do not cut flowers until fall of the first year.
  - 2) Leave two leaves on the stem.
  - 3) Do light, fall pruning and more thorough pruning in the spring.
- b) Hybrid teas, floribunda, and grandiflora
  - 1) In the fall, remove only the tops of the branches that catch in the wind.
  - 2) Remove not less than 18 inches, unless winter kills them.
- c) Climbing roses
  - 1) Prune in late spring immediately after flowering.
  - 2) Remove old canes past flowering close to base.
- d) Climbing hybrid teas and other everblooming climbers
  - 1) Do little or no pruning for the first two to three years.
  - 2) Prune only to shape and remove dead canes.
  - 3) Prune late in the dormant period as buds break.
  - 4) Leave only two to three major canes.
  - 5) Allow new ones to develop.

6) Remove old canes close to ground level.
7) Keep two to three main canes.

e) Procedures for all roses
   1) Remove all dead wood.
   2) Remove diseased, broken, or injured wood.
   3) Remove shoots from the base that are not from the main plant.
   4) Remove crossing branches through the center of the plant or those that rub.
   5) Prune to enhance the shape of the plant.
   6) Remove branches to allow good air movement through the plant.
   7) Make cuts one-fourth inch above a strong bud facing the outside.
   8) Cover large cuts with pruning wound dressing.
   9) Make cuts clean and smooth by using sharp pruning shears.

F. Other activities

1. Obtain permission to prune the landscape plants outside school. Practice identifying what types of cutting needs to be done. Practice making proper cuts according to the procedure in the student reference. The students should know what tools should be used for each cut.

2. Take students on a field trip to practice identifying pruning cuts that need to be made.

G. Conclusion

Being able to identify the pruning cuts that need to be made, and then making the pruning cuts correctly, are the two keys to maintaining healthy trees and shrubs.

H. Competency

Prune trees, shrubs, hedges, and roses.

I. Answers to Evaluation

1. b
2. a
3. a
4. b
5. b
6. c
7. c
8. c
9. d
10. b
11. a
12. up to discretion of instructor

J. Answers to Work Sheet 3.1

1. a, b, e, f, g, j, m, o
2. d, e, f, g
3. b, c, h, i, j

UNIT VI - INSTALLATION AND MAINTENANCE OF TREES AND SHRUBS Name ____________________

Lesson 3: Pruning Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Where should a "heading back" cut be made when pruning a small branch?

   a. In between the buds
   b. Just above the bud
   c. Just below the bud
   d. Through the bud

2. Where do watersprouts grow?

   a. Along horizontal branches
   b. At the base of the tree
   c. At the ends of branches
   d. From terminal buds

3. When should spring flowering shrubs be pruned?

   a. After they flower
   b. Every two years
   c. Just before they flower
   d. When they are dormant

4. Where do tree suckers grow?

   a. Along horizontal branches
   b. At the base of the tree
   c. At the ends of branches
   d. From the terminal buds

5. How should shrubs be sheared into hedges?

   a. The same width at the top and bottom
   b. Wider at the bottom
   c. Wider at the top
   d. Vase-shaped

6. When can plant wounds be treated?

   a. In the spring or early summer
   b. After the wounds start to heal
   c. As soon as they are made
   d. When the plant is dormant

7. Where is the first cut made when making a three-part cut?

   a. Lower side of the branch one to two inches away from the trunk
   b. Upperside of the trunk one to two inches away from the trunk
   c. Lower side of the branch three to four inches away from the trunk
   d. Upper side of the branch three to four inches away from the trunk

8. Where should the blade be placed when pruning a branch with lopping shears?

   a. Close to the trunk on the lower side
   b. Away from the trunk on the lower side
   c. Close to the trunk on the upper side
   d. Away from the trunk on the upper side

9. Where should the third cut be made when cutting a large limb from a tree?

   a. As close to the tree as possible
   b. Halfway between the end of the stub and the trunk
   c. Close to the trunk on the bottom and away from the trunk on the top of the stub
   d. Past the wrinkled bark and angled slightly out

10. What is the most desirable angle for branch attachment?

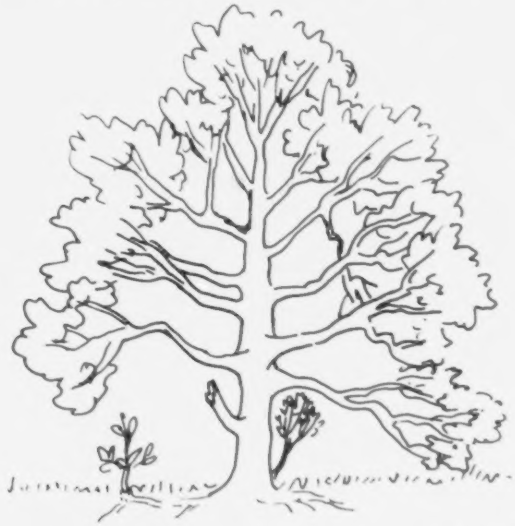
   a. A very narrow angle
   b. At right angles or 45° angles
   c. Hanging down from the trunk at 85°
   d. Angle does not matter

11. Which of the following is true concerning topping a tree?

   a. It is unsightly and should only be done if absolutely necessary.
   b. It should never be done.
   c. It produces the most beautiful trees.
   d. It is the most desirable way to prune.

Select the branches that need to be pruned in the following diagram.

12.

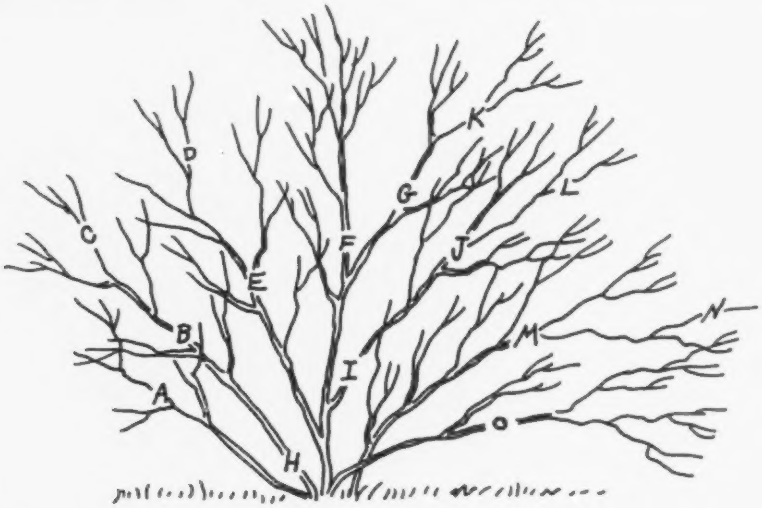


Lesson 3: Pruning

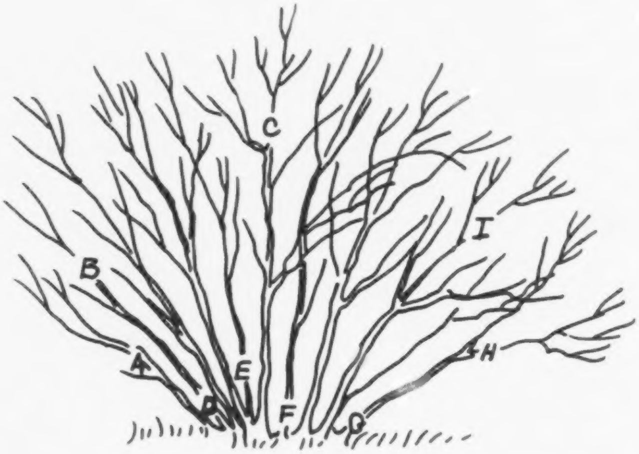
Work Sheet 3.1: Pruning Cuts

Answer the questions below by indicating which lettered branches should be removed.

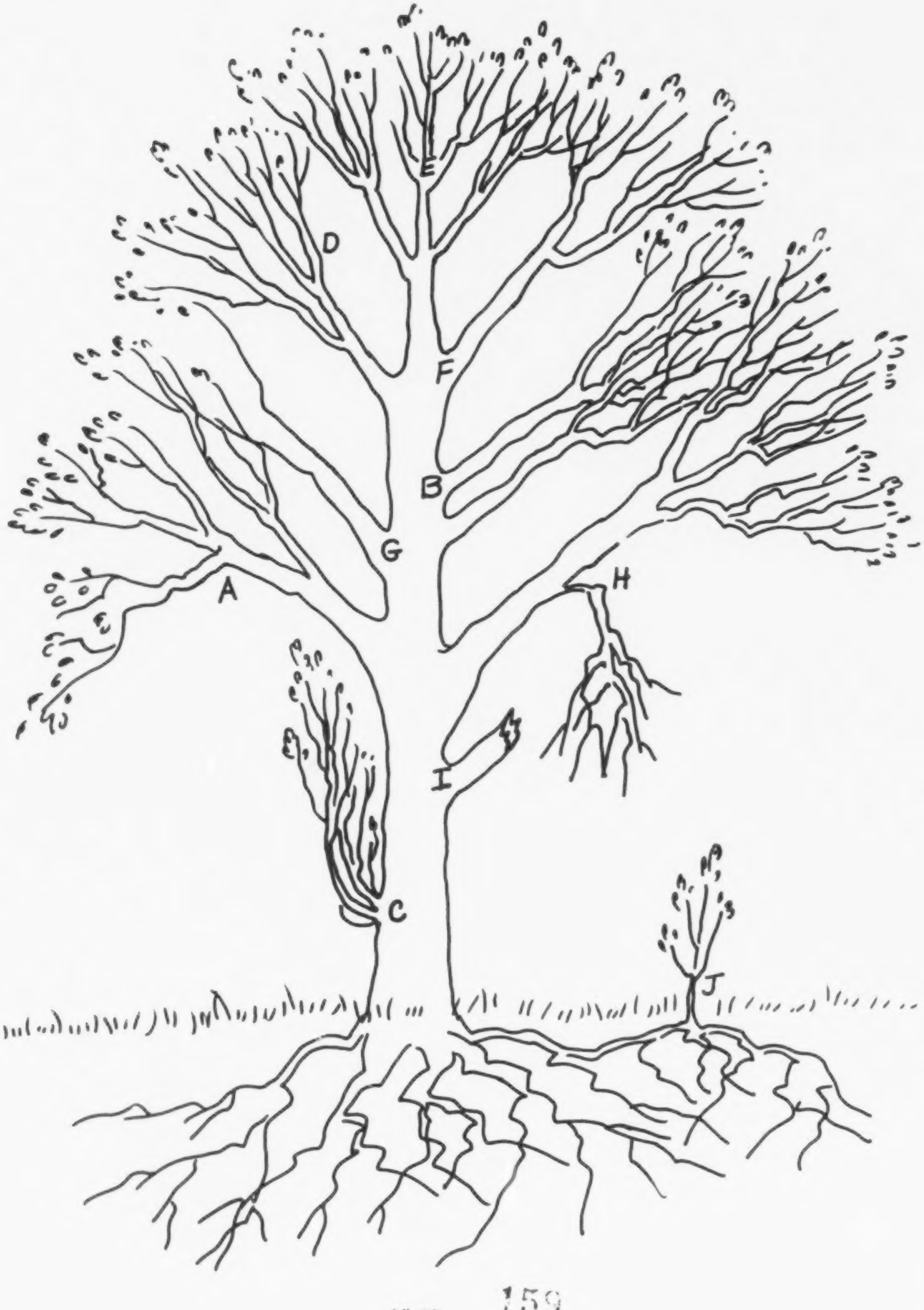
1. Which eight branches should be removed to "head back" the shrub pictured below?



2. Which five branches should be removed to "thin out" the shrub pictured below?



3. Which five branches should be pruned in the tree pictured below?


E
D
F
B
G
A
H
I
C
J

Lesson 3: Pruning

Job Sheet 3.1: Making Pruning Cuts

Objective: Upon completion of this job sheet the student will be able to make a pruning cut used for "heading back." This is for removing a small branch from a tree and removing a large branch from a tree.

Materials and Supplies Needed:

1. Hand pruning shears
2. Lopping shears
3. Pruning saw

Procedures:

1. "Heading back" using hand pruning shears (Figure 3.1)
    a. Choose the place to cut. If the bud is facing outward the branch will face outward.
    b. Make the cut one-fourth inch above the bud at a 45° angle.

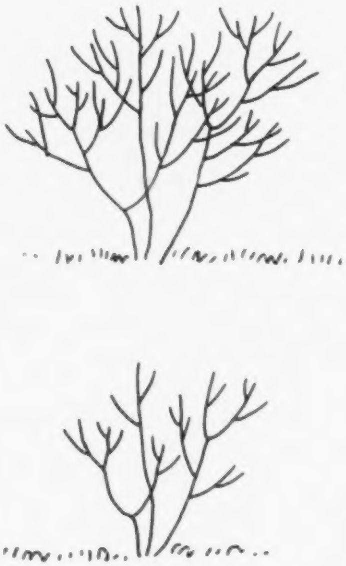


Figure 3.1

2. Removing a small branch using lopping shears. (Figure 3.2)
    a. Select the branch to be removed.
    b. Place the lopping shears around the branch with the blade of the shears closest to the main trunk, and the hook below and away from the plant.

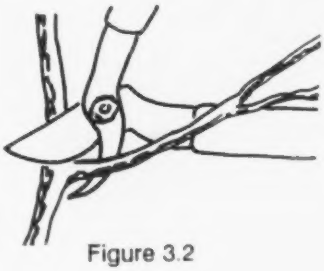


Figure 3.2

3. Removing a small branch using a pruning saw
    a. Select the branch to be cut.
    b. Make the first cut below the branch half way through the branch.
    c. On the upperside of the branch, line the saw up with the lower cut.
    d. Make the second cut on the upper side of the branch to meet the first, lower cut.
    e. Be cautious of the falling branch.
    f. Paint wound with pruning sealer.

4. Removing a larger limb using a pruning saw (Figure 3.3)

    a. Select the branch to be removed.

    b. Make the first cut on the under side of the limb three to four inches out from the trunk.

    c. Make the second cut on the upper side of the limb about one to two inches out from the trunk. The tree limb will fall away. Be cautious of the falling limb.

    d. Make the third cut to remove the remaining stub. Cut outside the callus layer; do not cut flush with the trunk. A cut that is too close will cause slow healing and chance of disease invasion.

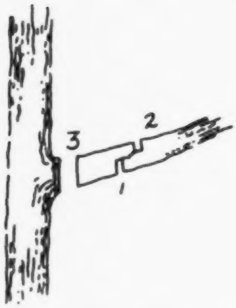


Figure 3.3

UNIT VI - INSTALLATION AND MAINTENANCE OF TREES AND SHRUBS

Lesson 4: Fertilizing

Objective: The student will be able to explain how to determine the nutrients needed by plants, their function in plants, symptoms of deficiency, and how to use a fertilizer label.

Study Questions

1. **Of the sixteen elements essential for proper plant growth, which are macronutrients and which are micronutrients?**
2. **How do these nutrients affect plant growth?**
3. **What are the visible symptoms of nutrient deficiency in plants?**
4. **What information is found on a fertilizer label?**
5. **In what three forms is nitrogen available to plants?**
6. **How does the type of soil and pH affect the absorption of nutrients to the plant?**
7. **In what ways can nutrient needs be determined for plants?**
8. **What are the benefits of fertilizing trees and shrubs?**
9. **What are three types of fertilizer?**
10. **What are the methods of applying fertilizer?**
11. **When should trees be fertilized?**
12. **What is the formula for figuring fertilizer cost?**

References

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
2. Transparency Master
   - a) TM 4.1: Fertilizer label
3. Work Sheet
   - a) WS 4.1: Fertilizer Calculations
4. Job Sheet
   - a) JS 4.1: Fertilizing a Tree Using the Soil Incorporation Method

Lesson 4: Fertilizing

TEACHING PROCEDURES

A. Review

Review previous lesson.

B. Motivation

Nutrients are essential for proper plant growth. Being able to diagnose and treat a nutrient deficiency, is necessary when maintaining a landscape.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students to list the elements they think a plant needs for good growth. List them on the board. Write the mnemonic devise on the board and explain. ("C. Hopkins Cafe managed by mine couzins Mo and Cleo).

   Of the sixteen elements essential for proper plant growth, which are macronutrients and which are micronutrients?

   a) Macronutrients
      1) Carbon (C)
      2) Hydrogen (H)
      3) Oxygen (O)
      4) Phosphorous (P)
      5) Potassium (K)
      6) Nitrogen (N)
      7) Sulphur (S)
      8) Calcium (Ca)
      9) Magnesium (Mg)
   b) Micronutrients
      1) Iron (Fe)
      2) Boron (B)
      3) Manganese (Mn)
      4) Copper (Cu)
      5) Zinc (Zn)
      6) Molybdenum (Mo)
      7) Chloride (Cl)

2. Ask the students to give the function of each nutrient needed. List them on the board. (See Chart.)

   How do these nutrients affect plant growth?

   a) Role of phosphorus in plant growth

    1) Stimulates root formation and growth
    2) Gives a rapid and vigorous start to plants
    3) Essential to energy transfer
    4) Hastens maturity
    5) Stimulates blooming
    6) Promotes disease resistance

b) Role of potassium in plant growth
    1) Promotes increased vigor and disease resistance to plants
    2) Essential to the formation and transfer of starches, sugars, and oils
    3) Promotes enzyme activation

c) Role of nitrogen in plant growth
    1) Induces rapid vegetative growth
    2) Necessary for chlorophyll manufacture
    3) Produces a healthy, green color
    4) Important to synthesis and structure of protein molecules

d) Role of sulphur in plant growth
    1) Encourages more vigorous growth
    2) Promotes root growth
    3) Essential to the formation of some proteins

e) Role of calcium in plant growth
    1) Improves general plant vigor
    2) A component of the cell wall
    3) Needed for cell division
    4) Promotes early root formation and growth
    5) Influences the absorption of other plant nutrients

f) Role of magnesium in plant growth
    1) Aids in the transport of phosphorus
    2) Influences absorption of other plant nutrients
    3) Aids in translocation of starch

g) Role of iron in plant growth
    1) Acts as an electron carrier in enzyme systems that cause oxidation to occur
    2) Essential to chlorophyll production

h) Role of boron in plant growth
    1) Influences water absorption
    2) Aids in translocation of sugar

i) Role of manganese in plant growth
    1) Essential in plant metabolism
    2) Essential for certain nitrogen transformations in plants

j) Role of copper in plant growth
    1) Acts as an electron carrier in enzyme systems
    2) Involved in plant respiration
    3) Aids in utilizing iron
    4) Needed for photosynthesis

k) Role of zinc in plant growth
    1) Important to plant metabolism
    2) Involved in the formation of some growth hormones
    3) Involved in the reproduction processes of certain plants
    4) Important to protein synthesis

l) Role of molybdenum in plant growth
    1) Essential to plant development and reproduction
    2) Acts as an electron carrier in enzyme systems which bring about oxidation reduction reaction in plants
    3) Does not take place in the absence of micro-nutrients

m) Role of chlorine in plant growth

    1) Affects root growth, but little more is known about effect on plants
    2) More likely to be toxic than deficient

3. Ask the students to name the nutrient deficiencies found in plants. List them on the board. (See chart.)

What are the visible symptoms of nutrient deficiency in plants?

a) Deficiency symptoms of phosphorous
    1) Slow growth and maturity
    2) Purplish leaves, stems, and branches
    3) Stunting of growth
    4) Premature leaf drop
b) Deficiency symptoms of potassium
    1) Mottling, spotting, streaking, or curling of leaves
    2) Leaves scorched on the margins or tips
    3) Burning at tip of leaf and proceeding downward
c) Deficiency symptoms of nitrogen
    1) Sickly yellow-green color
    2) A distinct, slow and stunted growth
    3) Drying up or burning of leaves which starts at the bottom of the plant and proceeds upward; drying starts at the top of the bottom leaves and proceeds down the center along the mid-rib
    4) Increased fall color
d) Deficiency symptoms of sulphur
    1) Young leaves light-green with even lighter veins
    2) Stalks short and slender
    3) Plant growth slow and stunted
e) Deficiency symptoms of calcium
    1) Young leaves in terminal bud hooked in appearance, then die at the tips and along the margin
    2) Roots short and branched
    3) Leaves have wrinkled appearance
    4) Exhibits deficiency symptoms of other nutrient deficiencies, since the proper balance of calcium influences absorption of other nutrients.
f) Deficiency symptoms of magnesium
    1) Loss of green color starting in the bottom leaves and later moving up the stalk - veins remaining green
    2) Slender and weak plant stem
    3) Mottled leaves
    4) Leaf tips turned or cupped upward
g) Deficiency symptoms of iron
    1) Mottled young leaves, principal veins remain green
    2) Short and slender stalks
h) Deficiency symptoms of boron
    1) Young leaves of terminal buds light-green at base, scorched bronze or red color
    2) In later growth, leaves twisted and stalk dries back to the terminal bud
    3) Stunted roots
    4) Stems cracked, brown inside
i) Deficiency symptoms of manganese
    1) Spots of dead tissue scattered over leaves
    2) The smallest veins green producing a checkered effect
    3) Leaves limp and curled
j) Deficiency symptoms of copper

    1) Young leaves permanently wilted spotting or mottling only at tip
    2) The twig or stalk just below tip and seed head becomes weak
  k) Deficiency symptoms of zinc
    1) Leaf spots in areas between veins and eventually secondary and even primary veins
    2) Leaves thick, small, pointed, and narrow
    3) Internodes short
  l) Deficiency symptoms of molybdenum
    1) Leaves similar in color to those deficient in nitrogen (sickly, yellow-green)
    2) Marginal scorching and rolling with reduced width
    3) Short internodes with severe deficiency
    4) Flowers few and small with severe deficiency
  m) Deficiency symptoms of chlorine - usually not deficient - no sign known

4. Show TM 4.1: Fertilizer Label. Ask the students to explain what each of the items are.

What information is found on a fertilizer label?

  a) Analysis
  b) Ratio
    1) Low analysis
    2) High analysis
    3) Relative proportion
  c) Fertilizer formula
  d) Types of fertilizer
    1) Organic
    2) Dry inorganic
    3) Liquid inorganic

5. Humans need nutrients and minerals to keep their bodies healthy. Minerals are available in the form of rocks. Humans are unable to use a mineral in rock form. It must be broken down into small particles and absorbed by plants. People eat the plants to absorb needed minerals. Plants are similar in how they absorb nitrogen. The nitrogen must be in a form that the roots can absorb.

In what three forms is nitrogen available to plants?

  a) Sodium nitrate
    1) Highly soluble
    2) Lowers pH
    3) Organic
  b) Ammonium nitrate
    1) Less soluble
    2) Lowers pH
  c) Urea formaldehyde
    1) Soluble, but slow to release
    2) Lowers pH
    3) Organic

6. Refer the student to the pH availability figure in Unit II. If more and more fertilizer is applied to a plant and it still looks deficient in nutrients, it is because the pH is inhibiting the absorption of nutrients. Money is wasted on fertilizer if the pH will not let it be absorbed.

How does the type of soil and pH affect the availability of nutrients to the plant?

- a) Type of soil - clay and silt hold more nutrients
- b) pH
  - 1) If too high or low, it can tie up nutrients.
  - 2) To lower pH use the following.
    - (a) Aluminum sulphate
    - (b) Sulphur
    - (c) Iron sulphate
  - 3) To raise pH use the following.
    - (a) Calcium (gypsum)
    - (b) Lime
  - 4) Be aware that one pH-altering substance can make some nutrients toxic, while making others unavailable.

7. Have students take a soil sample. Prepare it to send to the local county extension agent for analysis. Use UMC Guide 9109 "Submitting a Soil Sample for Testing". Ask the agent about having a foliar nutrient test done. Guide sheet 9110 "Sampling Your Soil for Testing" will be helpful for taking the sample. Guide 9111 "Using Your Soil Test Results" will be helpful in interpreting the results.

In what ways can nutrient needs be determined for plants?

- a) Signs of low nutrition
  - 1) Poor tree growth
  - 2) Pale green or yellow leaves
  - 3) Mottled patterns between veins
  - 4) Dead spots
  - 5) Stunted leaves or early loss of leaves
- b) Measure tree growth
  - 1) Current season growth - from tip to first set of bud scale scars
  - 2) Previous season growth - the distance between these bud scale scars and the next set down
- c) General tree vigor determined by measuring several twigs during past 3-4 years

8. Fertilizers are great to pick up where nature left off. All the nutrients a plant needs are not always found in the soil. Supplementing with fertilizer helps ensure that the life of a tree will be a long and healthy one. It is similar to the reason humans take vitamins, to ensure they get all the nutrients they need to stay healthy.

What are the benefits of fertilizing trees and shrubs?

- a) Improves the overall vigor
- b) Makes leaves grow larger and darker green
- c) Encourages rapid growth of young trees
- d) Maintains general health of landscape plants
- e) Makes plants less susceptible to certain pests and diseases
- f) Prevents further decline

9. The type of fertilizer used depends on how often landscaper want or can make application. The liquid or water soluble fertilizers last the shortest amount of time. The slow release fertilizers tend to last the longest but are also more expensive. Landscapers have to determine what is more expensive; the fertilizer or the labor it takes to supply it.

What are three types of fertilizer?

a) Dry
b) Liquid
c) Organic

10. Have the students fertilize an established tree on the school campus. Use JS 4.1.

What are the methods of applying fertilizer?

a) Surface application
b) Soil incorporation
c) Foliar sprays
d) Fertilizer spikes and slow release pellets

11. Just as humans eat when they are the most hungry; trees should be fertilized when they most need it; when they are rapidly growing.

When should trees be fertilized?

a) When rapidly growing
b) Nitrogen - two weeks before spring growth
c) Do not fertilize in late summer
    1) Results in winter damage
    2) Better fall color
d) Foliar sprays - after a few leaves reach mature size

12. Have the students complete WS 4.1. Estimating Fertilizer Cost

What is the formula for figuring fertilizer cost?

$$\overset{\text{(A)rea}}{400 \text{ square feet}} \times \overset{\text{(R)ate}}{\frac{1 \text{ pound Nitrogen}}{1{,}000 \text{ square feet}}} \times \overset{\text{(N)utrient analysis}}{\frac{100 \text{ pounds fert.}}{10 \text{ pounds of N of fert.}}} = 4 \text{ lbs}$$

N = Nitrogen

F. Other Activity

Take the students on a field trip to identify as many nutrient deficiencies as possible in the plants they see. Have them recommend a nutrient that would correct the deficiency.

G. Conclusion

The macronutrients nitrogen, phosphorus, and potassium are the three most important nutrients to plants. Micronutrients are also essential, but in lesser amounts. All plants benefit from fertilizer applications.

H. Competency

Fertilize trees and shrubs.

I. Answers to Evaluation

1. c
2. a
3. c
4. d
5. c
6. b
7. a
8. c
9. a
10. c
11. a
12. d
13. b

J. Answers to Work Sheet 4.1

1. $165 \text{ sq ft} \times \frac{3 \text{ lbs P}}{1{,}000 \text{ sq ft}} \times \frac{100 \text{ lbs fert.}}{8 \text{ lbs P}} = \frac{59{,}400}{8{,}000} = 7.43 \text{ lbs fert.}$

2. $707 \text{ sq ft} \times \frac{2 \text{ lbs N}}{1{,}000 \text{ sq ft}} \times \frac{100 \text{ lbs fert.}}{10 \text{ lbs N}} = \frac{141{,}400}{10{,}000} = 14.14 \text{ lbs fert.}$

3. $79 \text{ sq ft} \times \frac{3 \text{ lbs N}}{1{,}000 \text{ sq ft}} \times \frac{100 \text{ lbs fert.}}{10 \text{ lbs fert.}} \times \frac{\$7.99}{10 \text{ lbs N}} = \frac{189{,}363}{100{,}000} = \$1.89$

4. $64 \text{ sq ft} \times \frac{1 \text{ lb N}}{1{,}000 \text{ sq ft}} \times \frac{100 \text{ lbs fert.}}{6 \text{ lbs N}} \times \frac{\$2.25}{5 \text{ lbs fert.}} = \frac{14{,}400}{30{,}000} = \$\ .48$

UNIT VI - INSTALLATION AND MAINTENANCE OF TREES AND SHRUBS Name ________________

Lesson 4: Fertilizing Date ________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which are macronutrients for plants?

    a. Calcium, nitrogen, iron
    b. Copper, sulphur, boron
    c. Magnesium, potassium, sulphur
    d. Phosphorous, potassium, manganese

2. Which are micronutrients for plants?

    a. Boron, iron, copper
    b. Chlorine, phosphorus, magnesium
    c. Manganese, molybdenum, calcium
    d. Zinc, chlorine, magnesium

3. How many pounds of 11-10-10 fertilizer should be applied to a bed that measures 15 by 75 feet if the desired rate of application is one pound of nitrogen per 1,000 square feet?

    a. 7.5
    b. 8.4
    c. 10.2
    d. 11.0

4. What may be caused by heavy nitrogen applications to plants?

    a. Floral initiation
    b. Lower soluble salts in the soil
    c. Longer stem internodes
    d. Vegetative growth

5. In what nutrient is a tree deficient when the leaves, stems, and branches turn a purplish color?

    a. Iron
    b. Nitrogen
    c. Phosphorus
    d. Potassium

6. What nutrient is deficient in a tree that has a sickly, yellow-green, leaf color, is slow growing, and the bottom leaves are browning?

    a. Iron
    b. Nitrogen
    c. Phosphorous
    d. Potassium

7. What will heavy phosphorous applications to plants cause?

   a. Floral initiation
   b. Lower soluble salts in the soil
   c. Longer stem internodes
   d. Vegetative growth

8. What ratio does the fertilizer analysis [illegible]-15-5 have?

   a. 1-1-1
   b. 3-4-2
   c. 2-3-1
   d. 2-7.5-2.5

9. What could be mixed with soil to lower the pH?

   a. Aluminum sulphate
   b. Agricultural lime
   c. Nitrogen
   d. Phosphorous

10. When is the best time to fertilize trees?

   a. In the early winter
   b. In mid-August
   c. In late winter
   d. New Year's Day

11. Which of the following is not a reliable way to determine if your tree needs fertilizer?

   a. Bark analysis
   b. Foliar analysis
   c. Look at the tree
   d. Soil test

12. How can tree growth be determined?

   a. By counting bud scale scars
   b. By counting buds
   c. By counting the number of leaves on the tree
   d. By measuring the distance between bud scale scars

13. In what area should fertilizer be applied to trees?

   a. Just around the trunk
   b. Slightly beyond the branch spread
   c. Three feet out from the trunk
   d. Twelve feet out from the trunk

Lesson 4: Fertilizing

Work Sheet 4.1: Fertilizer Calculations

Complete the following questions.

1. How many pounds of 6-8-4 fertilizer should be applied to an area 15 x 11 feet if three pounds P (phosphorus) is wanted per 1,000 square feet?

2. If the extension agent recommends an application of 10-20-10 fertilizer, at the rate of two pounds N per 1,000 square feet around a tree with a branch spread of 30 foot diameter, how much fertilizer would be needed?

3. A ten pound bag of 10-20-10 fertilizer costs $7.99. what will it cost to apply three pounds of N per 1,000 square feet around a tree with a branch spread of 10 foot diameter?

4. The branch spread of a tree is has a 9 foot diameter canopy. How much would it cost to apply 1 pound of N per 1,000 square feet of a 6-8-4 fertilizer that costs $2.25 per 5 pound bag?

Lesson 4: **Fertilizing**

Job Sheet 4.1: Fertilizing a Tree Using the Soil Incorporation Method

Objective: Upon completion of this job sheet, the student will be able to fertilize a tree.

Materials and Supplies Needed:

1. Water sprinkler
2. Hose
3. Measuring tape
4. Soil auger or one inch iron rod
5. Measuring cup
6. 2-1-1 or 3-1-1 ratio fertilizer (granular)

Procedure:

1. Soak the soil beneath the tree the day before the tree will be fertilized, if the soil is not moist.

2. Measure the tree trunk four and one-half feet from the ground. If the tree trunk is less than six inches use one to two pounds of fertilizer per year. If the tree is more than six inches use two to four pounds per year.

3. Calculate the amount of fertilizer by multiplying the tree trunk diameter by the proper rate of fertilizer. Example: four inches x two pounds per year = eight pounds fertilizer needed.

4. With a soil auger or one inch iron rod, drill 10-15 holes for every inch of trunk diameter.

5. Calculate the number of holes needed by multiplying the trunk diameter by the number of holes for each inch. Example: four inches x 15 holes = 60 holes total.

6. The holes should be 12" - 15" deep. Place the holes about two feet apart in concentric circles around the trunk. The inner circle should be two feet away from the trunk. The outer circle should be beyond the diameter of the branch spread.

7. Apply one-fourth to one-half cup of fertilizer to each hole.

8. Calculate exactly how much fertilizer should be applied to each hole by multiplying the number of pounds needed by 16 ounces (16 ounces in a pound) to get the total number of ounces needed. Then divide the number of ounces by the number of holes to get the number of ounces per hole. Then convert ounces to cups by dividing the number of ounces per hole by eight ounces (eight ounces in a cup). The decimal equivalent of one-fourth cup = .25, one-third cup = .33, and one-half cup = .5.

   Example: 8 pounds x 16 ounces/pound = 128 ounces
   128 ounces ÷ 60 holes = 2.13 ounces per hole
   2.13 ounces ÷ 8 ounces/cup = .266 cups per hole
   .266 = slightly over one-fourth cup but not one-third cup

9. Soak the area with a lawn sprinkler. The holes may be left open or closed as desired.

UNIT VI - INSTALLATION AND MAINTENANCE OF TREES AND SHRUBS

Lesson 5: Irrigation and Drainage

Objective: The student will be able to determine when and how much to irrigate and what methods to use.

Study Questions

1. **What factors should be considered when figuring how often and at what rate trees and shrubs should be watered?**
2. **What makes the watering requirements different for established and newly-planted trees and shrubs?**
3. **What are the various irrigation systems used when watering trees and shrubs?**
4. **What irrigation and drainage factors should be considered for trees in landscape planters?**

References

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
2. Job Sheet
   a) JS 5.1: Determining the Amount of Water Applied by a Sprinkler

UNIT VI - INSTALLATION AND MAINTENANCE OF TREES AND SHRUBS

Lesson 5: Irrigation and Drainage

TEACHING PROCEDURES

A. Review Unit II, Lessons 2 and 3.

B. Motivation

Supplying enough moisture to a tree is not as easy as one may think. When applying water by hand, it is easy for the person to get tired before the tree gets enough water. Demonstrate watering a tree by hand. Water for one to two minutes then, with a spade, dig down into the soil to show how far the water has penetrated the soil. Probably it only penetrated two to three inches. Explain that most of the feeder roots (the roots that take up the most water) are three feet below the soil surface.

C. Assignment

D. Supervised study

E. Discussion

1. Create this scenerio: a student, Joyce, was given a job of keeping a valuable tree alive one summer. Joyce will be paid $500 at the end of the summer if the tree survives. Ask the students how they would determine how often and how much to water this valuable tree.

   What factors should be considered when figuring how often and at what rate trees and shrubs should be watered?

   a) Individual plant requirements and age
   b) Weather
      1) Temperature
      2) Wind
      3) Humidity
      4) Hours of radiation
   c) Time and amount of last rainfall
   d) Root system
      1) Deep and wide spreading, more opportunity for water
      2) Shallow roots
         (a) Only have top three feet of soil to get water from
         (b) Need water more often
   e) Type of soil
      1) Sandy soil holds less water than a clay soil.
      2) Water moves more quickly through sand than clay.
      3) Plants absorb water between field capacity and wilting point.
      4) Water rarely moves sideways.
   f) Watering practices
      1) Thorough, but infrequent watering is best.
      2) Frequent, light watering causes shallow roots.
      3) Frequent, heavy watering causes waterlogged roots.
      4) Overwatering leaches out nutrients and drowns roots.
   g) Knowing when to water
      1) Signs from plant

        - (a) Wilted leaves
        - (b) Change in leaf color, dark-green to gray-green
        - (c) Leaves changed from shiny to dull
    - 2) Evapotranspiration and available moisture
    - 3) Tensiometer
    - 4) Testing soil by feeling

2. Because a baby is smaller than adult, it cannot hold as much food or water as an adult. Therefore, a baby must be fed more often to supply the energy needed to survive. The same idea can be used for a small, newly-planted tree. The root system of a newly-planted tree is small and cannot absorb as much water as a large, established, root system. Therefore, it must be watered more often. A young tree will not handle moisture stress as well as an older, established tree. Since it is smaller it does not hold as much water in reserve as an older tree.

    What makes the watering requirements different for established and newly-planted trees and shrubs?

    - a) Newly-planted trees and shrubs have a very limited root system.
    - b) Established plants have a more extensive root system.

3. Based on time, money, size of land, and water supply; there is a watering system that will work in most situations. Ask the students how they would choose an irrigation system. Have sprinklers, soaker hoses, etc. on hand for the students to look at. Select an area outside and discuss the factors affecting the type of irrigation system needed to maintain it. Have the students complete Job Sheet 5.1.

    What are the various irrigation systems used when watering trees and shrubs?

    - a) Dish or berm
        - 1) Used for newly-transplanted trees
        - 2) As wide as the dripline
        - 3) Water applied by hose, soaker, or built-in bubblers
        - 4) Water not resting against trunk
    - b) Furrow
        - 1) Used along a row of trees
        - 2) Fairly level, slight slope for water movement
        - 3) Water applied starting quickly, then diminishing
        - 4) Salt accumulation on top of ridges
    - c) Sprinkler
        - 1) Easy to use
        - 2) Not always uniform
        - 3) Water often applied faster than soil can absorb
        - 4) Distribution effects of wind
        - 5) Flower damage
        - 6) Early in day so leaves can dry
        - 7) Measurement by placing cans to catch water
    - d) Drip irrigation
        - 1) Cuts waste of water
        - 2) Delivers a small amount at a time to individual plants
        - 3) Distribution is uniform
        - 4) Plant stays dry
        - 5) Takes longer, but wastes little
        - 6) Good for use on slopes
    - e) Root irrigator

1) Good for slopes
2) Applied directly at the roots
3) 12-18" in the ground

4. A landscape planter is 100% self-contained. The irrigation water, as well as an area for run off, must be provided within the palnter. It is easy to overwater trees in planters so a planter must be carefully planned.

What irrigation and drainage factors should be considered for trees in landscape planters?

a) Soil
    1) Should drain rapidly
    2) Texture and depth most important
    3) 50% coarse sand, 50% organic material
b) Irrigation system
    1) Self-contained - low maintenance
    2) Low application rate - less overwatering and water waste
c) Drainage system
    1) To handle the maximum amount of extra water
    2) Two percent slope on bottom of container
    3) Rapid draining of water to bottom
    4) Drain tile in the bottom
        (a) One inch diameter plastic tube
        (b) Cover with fiber glass filter

F. Other activity

Take the students on a field trip to see various irrigation systems in use, or have them recommend types of systems to use in areas visited.

G. Conclusion

There are many factors to consider when irrigating trees and shrubs. They must all be carefully evaluated so the proper amount of water requirement can be estimated, and method of irrigation can be decided.

H. Competency

Determine the best methods of irrigation in various situations.

I. Answers to Evaluation

1. a
2. a
3. d
4. b
5. d
6. c
7. a. x
    b. x
    c.
    d. x
    e.

	f.	
	g.	x
	h.	
	i.	x
	j.	x
	k.	x
8.	a.	D,O
	b.	D,O
	c.	D
	d.	D,O
	e.	D
	f.	O
	g.	D
	h.	O

UNIT VI - INSTALLATION AND MAINTENANCE OF TREES AND SHRUBS

Name ____________________

Date ____________________

Lesson 5: Irrigation and Drainage

EVALUATION

Circle the letter that corresponds to the best answer.

1. What is the result of infrequent, thorough watering?

   a. Deep root system
   b. Overwatering
   c. Shallow root system
   d. Underwatering

2. When is the best time to use sprinklers?

   a. In early morning
   b. In late evening
   c. When temperatures are hot
   d. When the wind is blowing

3. Where is basin irrigation best used?

   a. On a grove of trees
   b. On an older, established tree
   c. On a row of trees
   d. On newly-planted trees

4. What is the best irrigation system to use on a steep slope?

   a. Dish irrigation
   b. Drip irrigation
   c. Furrow irrigation
   d. Sprinkler

5. Which irrigation system should not be used if a tree needs to be watered, but the wind is blowing strongly?

   a. Basin irrigation
   b. Drip irrigation
   c. Furrow irrigation
   d. Sprinkler

6. What should be avoided when using landscape planters?

   a. Anchorage
   b. Fertilizing
   c. Overwatering
   d. Underwatering

Mark an X next to the conditions that increase watering requirements.

7. a. ____ Newly-planted tree
   b. ____ Coarse-textured (sandy) soils
   c. ____ Fine-textured (clay) soils
   d. ____ High temperatures
   e. ____ Cool temperatures
   f. ____ High relative humidity
   g. ____ No mulch used
   h. ____ Plants are dormant
   i. ____ Grove of trees
   j. ____ Low relative humidity
   k. ____ Areas along driveways and curbs

Indicate which of the following symptoms is from a tree deficient in water by marking a "D" in the blank. Mark an "O" in the blank next to the symptoms of overwatering a plant. Place a "D" and "O" in the blank next to those that are symptoms of both.

8. a. ____ Wilting
   b. ____ Leaf drop
   c. ____ Marginal necrosis
   d. ____ Reduced shoot growth
   e. ____ Gray-green, purplish leaf color
   f. ____ Yellow (chlorotic) look on new leaves
   g. ____ Few roots, bright-colored
   h. ____ Roots dark and spongy

Lesson 5: **Irrigation and Drainage**

Job Sheet 5.1: **Determining the Amount of Water Applied by a Sprinkler**

Objective: **Upon completion of this job sheet, the student will be able to determine the amount of water applied by a sprinkler in one hour.**

Materials and Supplies Needed:

1. Hose
2. Sprinkler
3. Containers - uniform size with wide, straight sides (number of containers depends on sprinkler area)
4. Ruler

Procedure:

1. Set up sprinkler.
2. Place uniform containers, no more than five feet apart throughout the sprinkler pattern.
3. Turn on water.
4. Operate for one hour (one-half hour if time is limited).
5. Measure the depth of water in inches in each container.
6. Add depths together and divide by the number of containers.
7. The result will be the average amount of water applied in one hour.
8. Answer the following questions.

   How long does it take to get one inch of water?

   Was the water applied uniformly?

UNIT VI - INSTALLATION AND MAINTENANCE OF TREES AND SHRUBS

Lesson 6: Disease and Pest Control

Objective: The student will be able to recognize and know control methods for common and destructive insects and diseases.

Study Questions

1. **What are some of the most common and destructive insects and their means of control in Missouri's trees and shrubs?**
2. **What are some of the most common and destructive diseases and their means of control in Missouri's trees and shrubs?**
3. **What are the most common noninfectious disorders found in trees and shrubs?**
4. **How is biological control used as a method to control insects and diseases?**

References

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
2. Work Sheets
    a) WS 6.1: Identifying Plant Insects
    b) WS 6.2: Identifying Plant Diseases

Lesson 6: Disease and Pest Control

TEACHING PROCEDURES

A. Review

Review previous lesson.

B. Motivation

Insects and diseases can seriously affect the appearance and value of horticulture crops. Part of landscape maintenance involves recognizing these pests and controlling them.

C. Assignment

D. Supervised study

E. Discussion

1. Discuss the stages of development and morphology (mouth parts) of insects and how they affect the control methods used. See Table 6.1 in the student reference.

   What are some of the most common and destructive plant insects and their means of control in Missouri's trees and shrubs?

   There are many common and destructive plant insects in Missouri, which are usually controlled by their feeding habits.

   a) Insect feeding methods
      1) Chewing
      2) Rasping-sucking
      3) Piercing-sucking
   b) Insect control methods
      1) Trap crops
      2) Radiation
      3) Beneficial insects
      4) Life-cycle interruption
      5) Systemic insecticides
      6) Contact poisons

2. Explain that diseases do not just happen. They are introduced and are a result of pathogens. Sanitation can keep many diseases under control. See Table 6.2 in student reference.

   What are some of the most common and destructive diseases and their means of control in Missouri's trees and shrubs?

   a) Diseases
      1) Pathogens
         (a) Bacteria
         (b) Fungi
         (c) Viruses

        - (d) Nematodes
    - 2) Host
    - 3) Correct environmental conditions
- b) Dissemination of pathogens
    - 1) Insects
    - 2) Splashing water
    - 3) Wind
    - 4) Animals (humans, too)
    - 5) Equipment and tools
- c) Pathogens' infectious stage
    - 1) Fungi spores
    - 2) Virus particle
    - 3) Strand of hyphae
    - 4) Bacterial ooze
- d) Method of pathogen entry
    - 1) Stomata
    - 2) Cuts
    - 3) Wounds
    - 4) Blossoms
    - 5) Roots
    - 6) Fruit
- e) Symptoms of diseases
    - 1) Wilting
    - 2) Color changes
    - 3) Rotting
    - 4) Death of tissue
    - 5) Increase in size (from malformed parts)
    - 6) Tunneling
    - 7) Holes
- f) Degrees of control
    - 1) Partial
    - 2) Absolute
    - 3) Profitable
- g) Control types and methods
    - 1) Prevention
        - (a) Pest-free stock
        - (b) Certified seeds
        - (c) Resistant varieties
        - (d) Cultural practices
        - (e) Sanitation
        - (f) Plant quarantines
        - (g) Chemical pesticides
    - 2) Suppression
        - (a) Sanitation
        - (b) Moisture modification
        - (c) pH modification
        - (d) Nutrient modification
        - (e) Chemical pesticides
        - (f) Biological control
    - 3) Eradication
        - (a) Hand pull weeds and cultivation
        - (b) Destruction of alternate host
        - (c) Crop rotation and soil treatment
        - (d) Remove rotten materials

(e) Isolation or destruction of plant host
(f) Chemical pesticides

3. Take students on a field trip to look for any signs of plant pests, diseases, or noninfectious disorders that may be present. Have the students complete WS 6.1 and WS 6.2. Plants can be seriously damaged by disorders that are not only caused by insects or disease, but by natural occurrences and human error, as well.

What are the most common noninfectious disorders found in trees and shrubs?

a) Soil or root problems
    1) Soil covering not allowing water or air to penetrate
    2) Toxic gases
    3) Damaged roots from construction
    4) Drought
    5) Girdling of roots or trunk
    6) Animal damage
b) Weather
    1) Extremely high or low temperature
    2) Extremely high or low moisture
c) Air quality - pollution
d) Chemical injury
    1) Herbicides
    2) Salts
e) Mechanical injury
    1) Automobiles
    2) Lawn mowers
    3) Vandalism
    4) Snow and ice damage
    5) Incorrect staking and guying

4. Discuss the damaging effect of chemicals on the environment and animals. Explain that "biological" control means natural control.

How is biological control used as a method to control insects and diseases?

a) Natural enemies of pests
b) Disease- and insect-resistant plants
c) Crop rotation
d) Natural pesticides taken from plants, i.e. chrysanthemum
    1) Pyreththroids
    2) Rotenone
e) New strains of microbes

F. Other activities

Have students collect as many insects as they can that are discussed in this unit. Label, and display them.

G. Conclusion

While insects and diseases may be controlled to the point of preventing economic loss, it is difficult to completely eradicate them. Biological control should be used in all possible situations.

H. Competency

Recognize common insects and diseases, the type of damage or symptoms they cause, and recommended control methods.

I. Answers to Evaluation

1. c
2. c
3. a
4. a
5. c
6. d
7. b
8. c

J. Answers to Work Sheets

1. Work Sheet 6.1 - Identifying Plant Insects:
   Answers are up to discretion of instructor.

2. Work Sheet 6.2 - Identifying Plant Diseases:
   Answers are up to discretion of instructor.

UNIT VI - INSTALLATION AND MAINTENANCE OF TREES AND SHRUBS

Name ____________________

Date ____________________

Lesson 6: Disease and Pest Control

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which pest is not an insect?

   a. Aphids
   b. Caterpillars
   c. Mites
   d. Scale

2. Which of the following is a noninfectious disorder?

   a. Anthracnose
   b. Crown Gall
   c. Girdling of the roots
   d. Powdery mildew

3. What type of control interferes with the reproduction of a pest?

   a. Biological control
   b. Chemical control
   c. Mechanical control
   d. Natural control

4. Which of the following is the best example of biological control of a pest?

   a. Introducing a natural enemy of the pest
   b. Removing the pest by hand
   c. Spraying the plant with water
   d. Spraying with a natural pesticide

5. Which pest control method is an example of mechanical control?

   a. Birds eating grubs
   b. Contact herbicides
   c. Pulling weeds by hand
   d. Releasing sterile males

6. Which includes prevention as a method of control?

   a. Crop rotation
   b. Destroying the plant host
   c. Hand picking insects off plants
   d. Using resistant varieties

7. Which includes using suppression as a type of control?

   a. Crop rotation
   b. Modification of nutrient availability
   c. Plant quarantines
   d. Using certified seeds

8. Which indicates profitable control?

   a. Removing most, but not all of the pests
   b. Removing all of the pests
   c. Removing pests only if the benefits outweigh the cost
   d. Removing all of the pests at any expense

Lesson 6: Disease and Pest Control

Work Sheet 6.1: Identifying Plant Insects

Collect two insects discussed in this unit. Tell what plant characteristics or symptoms were used to find the insects. Identify and display the insects. Tell what treatment or method of control could be used for each insect problem.

UNIT VI - INSTALLATION AND MAINTENANCE OF TREES AND SHRUBS WS 6.2

Lesson 6: Disease and Pest Control

Work Sheet 6.2: Identifying Plant Diseases

Collect samples of a tree or shrub that has signs of disease. Tell what characteristics were used to find the disease. Identify and display the samples. Tell what treatment could be used to control the disease.

UNIT VII - INSTALLATION AND MAINTENANCE OF BEDDING PLANTS AND GROUND COVERS

Lesson 1: Transplanting Bedding Plants and Ground Covers

Objective: The student will be able to transplant bedding plants and ground covers.

Study Questions

1. **How should a planting area be prepared for flowers?**
2. **How should flowers and ground covers be transplanted?**
3. **What types of mulches can benefit bedding plant and ground cover plantings?**

References

1. Landscaping and Turf Management. (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
2. Work Sheet
    a) WS 1.1: Determining Plant Spacing
3. Job Sheets
    a) JS 1.1: Preparing the Flower Bed
    b) JS 1.2: Transplanting Bedding Plants

UNIT VII - INSTALLATION AND MAINTENANCE OF BEDDING PLANTS AND GROUND COVERS

Lesson 1: Transplanting Bedding Plants and Ground Covers

TEACHING PROCEDURES

A. Introduction

Flower gardens, beds, and borders are a beautiful addition to a landscape. A landscaper must know how to properly prepare the soil, transplant flowers and ground covers, and use mulches, in order to install a successful garden, bed, or border.

B. Motivation

Show slides of beautiful flower gardens, beds, and borders. Point out the sequence of heights; tallest in the back to shortest in the front. Also point out proper spacing in width.

C. Assignment

D. Supervised study

E. Discussion

1. Select a site on the school campus to create a flower bed or border. Have the students prepare the bed for planting flowers. The soil test should have been done in unit II. If not, test the soil. Have the students complete Job Sheet 1.1.

How should a planting area be prepared for flowers?

a) Prepare the whole area, rather than individual holes.
b) Take a soil test.
c) Remove all weeds.
d) Organic matter can be spread two inches thick over the soil.
e) Add lime or sulphur, if needed, to adjust the pH.
f) Add two to three pounds of fertilizer per 100 square feet.
g) Work additions into the top six inches of soil.
h) Rake the area smooth.

2. Have the students complete WS 1.1 and JS 1.2 after discussion of this material.

How should flowers and ground covers be planted?

a) Be sure the ground temperature is warm enough.
b) Determine the spacing before planting.
    1) Annuals
        (a) Follow the guidelines on the seed packet or label.
        (b) Close spacing allows for a quick fill-in. Negative factors are:
            (1) It is more expensive.
            (2) It increases chance for disease.
    2) Ground covers
        (a) In a highly visible area plant closer together
        (b) A staggered arrangement fills in more quickly.
c) Follow the cultural requirements of a plant. Therefore, plant:

        1) Sun-loving plants in sun.
        2) Shade-loving plants shade.
    d) Do not plant shorter plants behind taller ones.
    e) Remove plants from the container.
        1) Plastic packs
            (a) Push the bottom with thumb.
            (b) Lift the rootball out of pack.
            (c) Straighten the roots coiled around the bottom.
        2) Individual clay or plastic pots
            (a) Tip upside down while holding a hand over the soil.
            (b) Tap the edge of the pot on a solid surface.
            (c) Let the rootball fall into the hand.
        3) Peat pots
            (a) Pots can be planted with the plant.
            (b) Remove the top rim down to soil line.
            (c) Wet the pot.
            (d) Bury completely.
    f) All plants should be moist when planted.
    g) Using a trowel, dig a hole slightly larger than the rootball.
    h) Plant at the same soil level as container.
    i) Tamp the soil in around roots.
    j) Water thoroughly.

3. Ask the students what mulch they have seen used most in the community. Shredded hardwood mulch is a very popular one to use. Point out that mulches are not only used for aesthetics; but are also important in conserving water, keeping weeds down, and keeping temperatures more constant.

What types of mulches can benefit bedding plant and ground cover plantings?

a) Purposes of mulches
    1) Conserving moisture
    2) Keeping weeds down
    3) Modifying temperatures
    4) Cutting down on weeding and cultivation
b) Possible types of mulches
    1) Shredded bark
    2) Old sawdust
    3) Pebbles
    4) Sphagnum moss
    5) Leaf mold
    6) Rotted manure
    7) Compost
    8) Rice, almond, or bean hulls
c) Soil changes from mulches
    1) Added nutrients
    2) Altered pH
    3) Nitrogen used by microorganisms in organic mulches
d) Application of mulch to ground covers after the ground freezes to keep it frozen

F. Other activity

After the students complete WS 1.2, have them determine the cost involved in covering the area with plants. Then have them space the plants closer together to fit more in the area (move on paper not the real bed) and determine the plant cost. Stress the point that this significantly increases the cost, and in the landscaping business a landscaper may lose profit if an excess of plants is used.

G. Conclusion

A showy bed of flowers can add to the beauty of a landscape design. It is essential to properly plan the spacing, plant selection, as well as to properly install the plants in order to have a successful design.

H. Competency

Prepare the soil of a flower bed, determine the number of plants to use, and transplant bedding plants and ground covers.

I. Answers to Evaluation

1. c
2. a
3. d
4. d
5. d
6. b
7. a
8. a

J. Answers to work sheet

WS 1.1: Determining Plant Spacing
Correct answers are up to instructor's discretion.

UNIT VII - INSTALLATION AND MAINTENANCE OF BEDDING PLANTS AND GROUND COVERS

Name ____________________

Date ____________________

Lesson 1: Transplanting Bedding Plants and Ground Covers

EVALUATION

Circle the letter that corresponds to the best answer.

1. When is the best time to add sulphur to a soil that will be planted with acid-loving plants?

   a. After applying the mulch
   b. After watering the plants in
   c. When preparing the soil
   d. When transplanting the plants

2. How much organic material should be added to the soil when preparing the flower bed?

   a. One-third of the final mix
   b. One-half of the final mix
   c. Two-thirds of the final mix
   d. Three-fourths of the final mix

3. How should plants be removed from cell packs?

   a. Plastic container should be planted with the plant
   b. Pulled out by the leaves
   c. Pulled out by the stem
   d. Pushed out from bottom of the container

4. When should tender annuals be planted?

   a. Two weeks before the last killing frost
   b. The day after the last killing frost
   c. One week after the last killing frost
   d. Two weeks after the last killing frost

5. How should plants in peat pots be planted?

   a. Pot must be removed.
   b. Pot must be buried one inch underground.
   c. Rim of the pot must be sticking up above ground.
   d. Rim of the pot should be removed, and plant planted at the same level as the soil in the pot.

6. Which is not a reason for using mulches?

   a. To conserve moisture
   b. To enhance the soil structure
   c. To keep weeds down
   d. To modify temperatures

7. At what depth should bedding plants be planted?

   a. At the same level they were in the pot
   b. One inch deeper than they were in the pot
   c. One inch higher than they were in the pot
   d. Up to the first set of leaves

8. Why must nitrogen be added to the soil when certain mulches are used?

   a. Microorganisms that break mulch down use nitrogen in the soil, stealing it from plants.
   b. Mulches need nitrogen to live.
   c. Mulches need nitrogen to work.
   d. When using mulch, the plants use more nitrogen.

UNIT VII - INSTALLATION AND MAINTENANCE OF BEDDING PLANTS AND GROUND COVERS WS 1.1

Lesson 1: Transplanting Bedding Plants and Ground Covers

Work Sheet 1.1: Determining Plant Spacing

Follow the steps below to determine plant spacing.

1. Measure the area to be planted.

2. List the plants to be planted. Beside each plant name, list the height and width the plant will reach when mature. This information can be found in Unit X, the plant label, or other resource.

	Name	Height	Width
a.			
b.			
c.			
d.			
e.			

3. Based on the width of the plant, determine how many plants will be needed. Example: the area is 48" long; Marigolds spread to eight inches wide; therefore, six marigolds will fill in one 48" row.

4. Based on the height of the plants, determine which plants will be in the back, middle, and front of the bed.

5. Draw a sketch of the area prepared for planting. Using a different symbol for each different species used, arrange the plants in the design to be planted.

Example:

marigolds = x (8")
dusty miller = o (6")
salvia = Δ (8")

Δ Δ Δ Δ Δ Δ

x x x x x x

o o o o o o o

UNIT VII - INSTALLATION AND MAINTENANCE OF BEDDING PLANTS AND GROUND COVERS JS 1.1

Lesson 1: Transplanting Bedding Plants and Ground Covers

Job Sheet 1.1: Preparing the Flower Bed

Objective: Upon completion of this job sheet, the student will be able to prepare a flower bed.

Materials and Supplies Needed:

1. Garden hoe
2. Spade or rototiller
3. Fertilizer
4. Organic material (peat, manure, etc.)
5. Sulphur or lime according to soil test results

Procedure:

1. A soil test should have been taken previously, if not follow procedures in Unit II, JS 2.1.
2. Remove weeds from area to be worked.
3. Spread organic material two inches thick over area.
4. Spread fertilizer over area as indicated by soil test.
5. Spread sulphur or lime at rate recommended on package, if a need is indicated by a soil test.
6. Work it into top six inches of soil, by turning the soil over with a spade, or using a rototiller.
7. Rake the soil smooth.

Lesson 1: Transplanting Bedding Plants and Ground Covers

Job Sheet 1.2: Transplanting Bedding Plants

Objective: Upon completion of this job sheet, the student will be able to transplant bedding plants.

Materials and Supplies Needed:

1. Bedding plants in packs or pots.
2. Hand trowel

Procedure:

1. Prepare planting site. See Job Sheet 1.1.
2. Determine spacing. See Work Sheet 1.1.
3. With trowel, dig a hole for the plants slightly larger than each rootball.
4. Remove plants from containers.
5. Place plants in hole at the same soil level as they were in the pot.
6. Gently tamp the soil down around the roots.
7. Mulch.
8. Water thoroughly.

UNIT VII - INSTALLATION AND MAINTENANCE OF BEDDING PLANTS AND GROUND COVERS

Lesson 2: Maintaining Bedding Plants and Ground Covers

Objective: The student will be able to maintain bedding plants and ground covers.

Study Questions

1. **What are the water requirements of bedding plants and ground covers?**
2. **When, and at what rate, are bedding plants and ground covers fertilized?**
3. **When is pruning or grooming appropriate?**

References

1. Landscaping and Turf Management. (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.

UNIT VII - INSTALLATION AND MAINTENANCE OF BEDDING PLANTS AND GROUND COVERS

Lesson 2: Maintaining Bedding Plants and Ground Covers

TEACHING PROCEDURES

A. Review

Review the previous lesson.

B. Motivation

Bedding plants are very showy and ground covers very useful. However, without the proper maintenance, bedding plants can lose their brilliance and ground covers will look drab and out of hand.

C. Assignment

D. Supervised study

E. Discussion

1. In most areas, water supply is not a problem. Stress to the students that there is no excuse for not keeping bedding plants well-watered after having gone to the trouble of planning and planting the plants. Have the students maintain the bed they have planted until the end of the school year. Seek volunteers to maintain it through the summer. Stress to students that it is better to water less frequently and more thoroughly, than to water lightly every other day. Mention that watering can become a boring job if a large area needs to be done by hand. It is easy for the person watering to get in a hurry and not give the plants enough water. They must be patient to be sure each plant gets enough. Demonstrate proper watering techniques to the students. Have each student water an area of the flower bed so they can get the experience of how much water to apply. Avoid wetting flowers and foliage, if possible.

   What are the water requirements of bedding plants and ground covers?

   a) Frequent (once a week), until established
   b) Once established; less frequent, deep, thorough watering
   c) Follow individual cultural requirements
   d) Water in the morning
   c) Keep foliage dry

2. Even though bedding plants are not heavy feeders, they will still benefit by a feeding once a month during the season. This will result in large, lush plants with more blooms and fewer problems with pests and diseases. Actively growing plants are less susceptible to pests and diseases. Seek volunteers to keep the plants fertilized during the summer. Demonstrate fertilizing practices, both dry application and liquid application. Then have the students try applying fertilizer.

   When, and at what rate, are bedding plants and ground covers fertilized?

   a) Bedding plants
      1) Once a month after established
      2) Two to three pounds of 1-2-1 fertilizer per 100 square feet

3) Sprinkled on surface and watered in

b) Ground covers

1) Soil test yearly
2) Three pounds of 1-2-1 fertilizer per 100 square feet
3) Applied in early spring

c) According to cultural requirements of specific plants

3. Trailing or spreading ground covers can get out of hand if not pruned to keep them in bounds. They also start to look drab if too much growth is kept on year after year. This causes the overall growth and vigor to slow down. Weekly "dead-heading" will lengthen the blooming time of annuals. If an established bed is available on the school campus, have the students practice removing dead flowers. If not available, make arrangements with the city park, a nursery, a garden center, or a greenhouse to try techniques on home grown plants.

When is pruning and grooming appropriate?

a) Ground covers

1) Prune when it looks dull or builds up thatch.
2) The best time is early spring before growth starts.
3) A lawn mower, string trimmer, or hand pruners can be used.

b) Bedding plants

1) "Dead-head" weekly.
   (a) Plants look better
   (b) Prolongs blooming period
2) Pinch when transplanting some bedding plants.
   (a) Promotes a bushier plant
   (b) Promotes more flowers
3) Stake tall plants.
   (a) Keeps plants upright
   (b) Protects from wind and rain damage

c) Ornamental grasses should not be cut back until spring.

d) Follow the cultural requirements for each plant.

F. Other activity

Have students observe and evaluate maintenance techniques at a park, nursery, or greenhouse.

G. Conclusion

Proper maintenance of bedding plants and ground covers will ensure vigorous, healthy, growth throughtout the growing season.

H. Competency

Maintain bedding plants and ground covers.

I. Answers to Evaluation

1. c
2. d
3. c
4. b
5. a
6. b
7. d

UNIT VII - INSTALLATION AND MAINTENANCE OF BEDDING PLANTS AND GROUND COVERS

Name ____________________

Lesson 2: Maintaining Bedding Plants and Ground Covers

Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. How often do newly-planted bedding plants need to be watered?

   a. Once a month
   b. Once a day
   c. Once a week until established
   d. Once a week throughout the season.

2. Which is not true of watering established bedding plants?

   a. They should be watered less frequently, but more thoroughly after they are established.
   b. It is best to water in the morning before the sun is high in the sky.
   c. The cultural requirements of each plant should be followed when watering.
   d. It is best to water in the late evening when the sun is down.

3. When should bedding plants be fertilized?

   a. Every three days
   b. Once a week
   c. Once a month
   d. Once during the season, in early spring.

4. What is the benefit of "dead-heading" bedding plants or ground covers?

   a. They grow bushier.
   b. They bloom for a longer period of time.
   c. It promotes seed development.
   d. It promotes foliage growth.

5. What results when pinching a bedding plant or ground cover?

   a. A bushier plant with more stems to bear flowers
   b. A longer blooming period
   c. A taller plant
   d. Increased bloom production

6. When should ornamental grasses be cut back?

   a. After they bloom
   b. In early spring
   c. In fall
   d. In winter

7. When should ground covers be fertilized?

a. Once every three days
b. Once a week
c. Once a month
d. Once during the season, in early spring

UNIT VIII - TURFGRASS

Lesson 1: Turfgrass Growth and Classification

Objective: The student will be able to explain the growth habits of turfgrass, its seasons of growth, and advantages and disadvantages of different turfgrasses.

Study Questions

1. **What are the different growth habits of turfgrass?**
2. **What are the differences between cool-season and warm-season turfgrasses?**
3. **What are the major advantages and disadvantages of: Kentucky bluegrass, tall fescue, fine fescue, perennial ryegrass, bermudagrass, and zoysiagrass?**

Reference

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.

UNIT VIII - TURFGRASS

Lesson 1: Turfgrass Growth and Classification

TEACHING PROCEDURES

A. Review

Review Unit III, Lesson 6 to recall the six main turfgrasses grown in Missouri.

B. Motivation

Place pots of the six most common turfgrasses in front of the students. Ask them which turfgrasses grow in their yards. Then ask students if they know how each turfgrass grows, or any characteristic they might be aware of that distinguishes each turfgrass.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students to discuss the growth habits of turfgrass.

   What are the different growth habits of turfgrass?

   a) Spreading
      1) Rhizomes are underground stems forming new independent plants with their own root systems that surface at a short distance from the mother plant.
      2) Stolons are aboveground stems forming new, independent plants with their own root systems that surface at a short distance from the mother plant.
   b) Bunching is the formation of new shoots or tillers only at the crown of the mother plant.

2. Ask students if they know what kind of turfgrass they have growing in their yards. Have them discuss when the grass appears to be actively growing and when it is dormant.

   What are the differences between cool-season and warm-season turfgrasses?

   a) Cool-season turfgrasses
      1) Grow best with daytime temperatures between 60°-75°F
      2) Green early in spring with very good growth
      3) Grow slowly in hot, summer and sometimes become dormant
      4) Green again in autumn with good growth
   b) Warm-season turfgrasses
      1) Grow best with daytime temperatures between 80°-95°F
      2) Grow actively during summer
      3) Green four to six weeks later in the spring than cool-season grasses.
      4) Turn straw-colored and become dormant after first autumn frost

3. Ask students if they know of any advantages or disadvantages one turfgrass might have over another, now that they know about warm-season and cool-season grasses.

What are the major advantages and disadvantages of Kentucky bluegrass, tall fescue, fine fescue, perennial ryegrass, bermudagrass, and zoysiagrass?

a) Kentucky bluegrass
   1) Sod-forming grass
   2) Grows best in unshaded areas
   3) Grows aggressively under favorable soil conditions
   4) Recovers with rhizomes following wear or injury
   5) Survives severe winter without damage
   6) Effective in seed blends and mixtures
   7) Effective establishment of lawn from seed
   8) Becomes dormant in hot and dry summers
   9) Moderately susceptible to diseases and insects
   10) Grows poorly in dense shade
b) Tall fescue
   1) Bunch grass
   2) Grows well in sun and moderate shade
   3) Withstands heavy traffic
   4) Grows well during extreme periods of drought
   5) Fewer disease problems
   6) Good resistance to insects
   7) Germinates rapidly
   8) Potential for clumping if stand is thinned
c) Fine fescue
   1) Grows exceptionally well in shade
   2) Usually mixed with Kentucky bluegrass or perennial ryegrass
   3) Performs well on droughty, infertile, coarse- textured soils
   4) Low fertility requirement
   5) Sensitive to some pesticides
   6) Not very resistant to disease
   7) Not very resistant to insects
d) Perennial ryegrass
   1) Germinates quickly
   2) Establishes in short period of time
   3) Excellent traffic tolerance
   4) Good for athletic fields
   5) Moderate degree of resistance to disease
   6) Some resistance to insects
   7) Does not tolerate hot, dry, summer conditions
e) Bermudagrass
   1) Aggressively spreading grass
   2) Recovers from damage and renovates quickly
   3) Grows exceptionally well in full sun
   4) Poor winter tolerance
   5) Good salt-tolerance
   6) Grows well during summer conditions
   7) Improved cultivars available
   8) Propagates only by sprigging, sodding, or plugging
   9) Very drought-tolerant
f) Zoysia grass
   1) Grows aggressively
   2) Performs best in full sun
   3) Moderate shade tolerance
   4) Grows well in most soil types

        5) Propagates by sprigging, sodding, or plugging
        6) Very drought-tolerant
        7) Problems with thatch

F. Other activities

1. Take students outside on school grounds to identify turfgrasses growing on campus and their growth habits.

2. Have students plant and grow seeds from each of the six major types of turfgrasses.

3. Have a BOAC take care of a public community area.

G. Conclusion

Turfgrasses can be classified according to their growth habits and the season in which they grow. There are many advantages and disadvantages of turfgrasses depending on growth habits and seasons.

H. Competency

List advantages and disadvantages of the six major turfgrasses grown in Missouri.

I. Answers to Evaluation

1. d
2. d
3. a
4. d
5. b
6. c

7. Include two of the following:
    a) Recovers from damage and renovation
    b) Grows well in full sun
    c) Grows aggressively
    d) Good insect resistance

UNIT VIII - TURFGRASS

Name ____________________

Lesson 1: Turfgrass Growth and Classification

Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which is not a characteristic of cool-season turfgrasses?

    a. Becomes dormant in summer
    b. Greens again in autumn
    c. Greens early in spring
    d. Grows best with daytime temperatures between 80-95°F

2. Which is a warm-season turfgrass?

    a. Kentucky bluegrass
    b. Perennial ryegrass
    c. Tall fescue
    d. Zoysia

3. Which is not a cool-season turfgrass?

    a. Bermudagrass
    b. Fine fescue
    c. Kentucky bluegrass
    d. Perennial ryegrass

4. What are grasses that spread by forming new, independent plants a short distance from the mother plant called?

    a. Branch
    b. Bunch
    c. Rhizome
    d. Sod forming

5. What are grasses that slowly spread by stems below ground that form only tillers at the crown of the mother plant called?

    a. Branch
    b. Bunch
    c. Rhizome
    d. Sod forming

6. Which is a disadvantage of using tall fescue?

    a. Germinates rapidly
    b. Grows well during extreme drought
    c. Potential for clumping if stand is thinned
    d. Withstands heavy traffic

Complete the following short answer question.

7. What are two advantages of using Bermudagrass?

   a.

   b.

UNIT VIII - TURFGRASS

Lesson 2: Turfgrass Establishment

Objective: The student will be able to describe the procedure for installing a lawn.

Study Questions

1. **How is an area prepared for the establishment of turf?**
2. **What are the procedures for installing turf?**
3. **Why is the time of planting grasses important?**
4. **What are important considerations when selecting turfgrass seed?**

Reference

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
2. Work Sheets
    - a) WS 2.1: Figuring Area
    - b) WS 2.2: Determining Seed and Sod Requirements for Lawn Areas

UNIT VIII - TURFGRASS

Lesson 2: Turfgrass Establishment

TEACHING PROCEDURES

A. Review

Review previous lesson. Review soil sampling.

B. Motivation

Having a well-established turf looks attractive and ties the landscape together.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students if any of them have prepared a site for installation of turf. Ask them what steps they may have taken.

   How is an area prepared for the establishment of turf?

   a) Test soil, if necessary.
   b) Remove debris from area.
   c) Remove topsoil and construct rough grade.
   d) Add lime, fertilizers, and soil amendments.
   e) Establish final grade.

2. Ask students if any have actually installed turf. Ask what methods they used and what steps they followed.

   What are the procedures for installing turf?

   a) Seeding
      1) Sow seed.
      2) Rake seed in and roll.
      3) Mulch.
      4) Water.
   b) Sodding - commercially grown turf cut into strips, equaling nine square feet or one square yard, with attached roots, rhizomes, or stolons
      1) Start with straight edge.
      2) Roll out strips.
      3) Place edges tightly together.
      4) Cut pieces to fit gaps.
      5) Roll.
      6) Water.
   c) Plugging - small squares or circles of sod placed at intervals of six to twelve inches
      1) Roll.
      2) Water.

d) Sprigging - pieces of turf planted in furrows, usually containing a stolon with roots and up to four nodes
   1) Press into the ground at desired intervals or broadcast and cover with soil.
   2) Water.

3. Ask students when they think the best times are to plant warm-season and cool-season turfgrasses.

   Why is the time of planting grasses important?

   a) Cool-season turfgrasses are planted in late summer to benefit from cool autumn temperatures and to have less competition from annual weeds in warmer weather.

      NOTE: Early spring planting is all right if fall planting is not practical.

   b) Warm-season turfgrasses are planted in late spring or early summer to receive optimum temperatures for growth.

4. Ask students if any of them have bought grass seed or other seed. Ask students what information they might find on a package of grass seed.

   What are important considerations when selecting turfgrass seed?

   a) Percentage of germination to expect
   b) Percentage of crop and weed seeds
   c) Percentage of noxious weeds

F. Other activities

1. Have students prepare a site for turfgrass installation.

2. Have students choose an appropriate method of installation for installing turfgrass in the prepared site.

G. Conclusion

Correctly preparing a site for turfgrass installation will help save needless hours of work at a later time. There are six major turfgrasses grown in Missouri. Each has advantages and disadvantages. There are four methods of installing turfgrass; seeding, sodding, plugging, and sprigging.

H. Competency

Describe the procedure for installing a lawn.

I. Answers to Evaluation

1. d
2. a
3. b
4. c
5. d

J. Answers to Work Sheets

WS 2.1

1. L x W = area 30' x 25' = 750 sq. ft.
2. L x W = area 40' x 10' = 400 sq. ft.
3. πr^2 = area 3.14 x 7.52 = 177 sq. ft.
4. $\frac{B \times H}{2}$ = area $\frac{25' \times 15'}{2}$ = 187.5 sq. ft.
5. L x W = area 45' x 15' = 675 sq. ft.

WS 2.2

1. 145' x 85' = 12,325 sq. ft.
2. 30' x 77.5' = 2,325 sq. ft.
3. 40' x 20' = 400 sq. ft.
4. Drive 25' x 25' = 625 sq. ft.; walk 25' x 7.5' = 187.5 sq. ft.
   625 sq. ft. + 187.5 sq. ft. = 812.5 sq. ft. (total area of walk and drive)
5. 35' x 25' = 875 sq. ft.
6. (12,325) - (2,325 + 400 + 812.5 + 875) = 7,912.5 sq. ft.
7. 7,912.5 sq. ft. + 9 sq. ft. = 879.167 rolls (9 sq. ft. in one roll of sod)
8. 145' x 55' = 7,975 sq. ft.
   7,975 sq. ft. - (2,325 sq. ft. + 812.5 sq. ft.) = 4,837.5 sq. ft.
   4,837.5 sq. ft. + 9 sq. ft. = 537.5 sq. ft.
9. 7,912.5 sq. ft. x $\frac{\text{3 lbs.}}{\text{1,000 sq. ft.}}$ x = 23.74 lbs. seed

UNIT VIII - TURFGRASS

Lesson 2: Turfgrass Establishment

Name ____________________

Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. What is the first step when preparing an area for installation of turfgrass?

   a. Add soil amendments
   b. Install underground sprinkler system
   c. Remove debris
   d. Take a soil test

2. What are small circles or squares of turf called?

   a. Plugs
   b. Seeds
   c. Sod
   d. Sprigs

3. Which is not a method of sprigging?

   a. Broadcasting and covering lightly with soil
   b. Spreading with a drop seeder
   c. Planting in furrows
   d. Pressing into the ground

4. When is the best time to plant warm-season turfgrasses?

   c. Early autumn
   d. Early spring
   c. Late spring
   d. Late summer

5. When is the best time to plant cool-season turfgrasses?

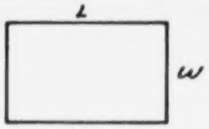
   a. Early summer
   b. Late autumn
   c. Late spring
   d. Late summer

UNIT VIII - TURFGRASS WS 2.1

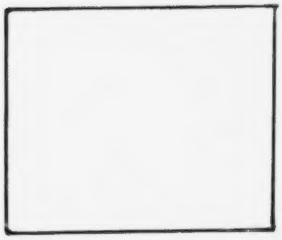
Lesson 2: Turfgrass Establishment

Work Sheet 2.1: Figuring Area

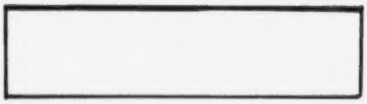
Using the given formulas, figure the area of the following shapes. Use a 1" = 20' scale. (Show your work.)

rectangle/square		area = length x width
triangle		area = base x height ÷ 2
circle		area = πr^2 π = 3.14 r = radius

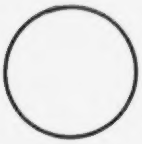
1.

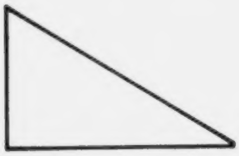


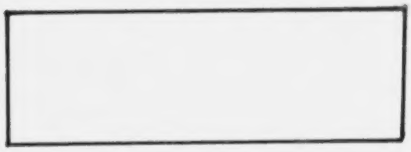
2.



3.



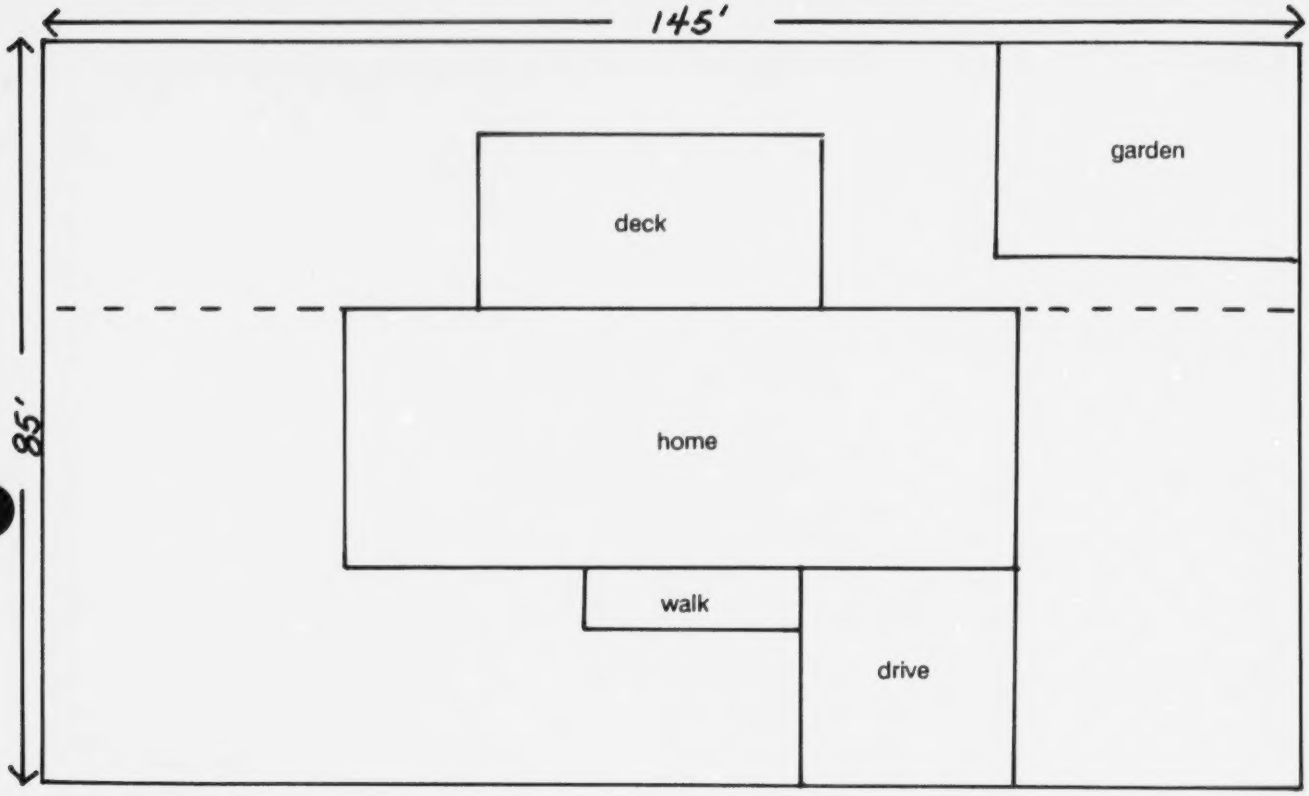
4. 

5. 

Lesson 2: Turfgrass Establishment

Work Sheet 2.2: Determining Seed and Sod Requirements for Lawn Areas

Answer the questions based on the home lot given. The scale is 1" = 20'.


145'
85'
garden
deck
home
walk
drive

1. What is the total area of the lot?

2. What is the area of the house?

3. What is the area of the deck?

4. What is the area of the drive and walk?

5. What is the area of the garden?

6. By subtracting the area in questions 2, 3, 4 and 5 from the area of the lot (Q1), determine the area of the lawn.

7. How many rolls of sod (1 square yard) would be needed to sod the entire lawn?

8. How many rolls of sod would be needed to sod just the front and side lawns?

9. Bluegrass is seeded on new lawns at a rate of three pounds per 1,000 square feet. At this rate, how much seed would be needed to seed the entire lawn?

Lesson 3: Turfgrass Maintenance

Objective: The student will be able to describe procedures to follow to successfully water, fertilize, and mow turfgrass.

Study Questions

1. **What are the fertility requirements for warm-season and cool-season turfgrasses?**
2. **How are frequency and rate of irrigation determined?**
3. **When is the appropriate time to mow turfgrass?**

References

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
2. Work Sheets
   a) WS 3.1: Figuring Area for Fertilizer Applications
   b) WS 3.2: Calculating Lawn Areas for Fertilizer Requirements
3. Job Sheet
   a) JS 3.1: Spreader Calibrations

UNIT VIII - TURFGRASS

Lesson 3: Turfgrass Maintenance

TEACHING PROCEDURES

A. Review

Review the previous lesson.

B. Motivation

Middle and upper class Americans generally hire individuals or companies to provide goods or services, rather than perform those tasks themselves. Lawn care businesses offering services such as mowing, watering, fertilizing, edging, and other turf maintenance jobs; have recently developed into a profitable service industry.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students if their lawns are fertilized. Ask what fertilizer they apply. Ask what equipment is used when applying fertilizer.

   What are the fertility requirements for warm-season and cool-season turfgrasses?

   In general, turfgrasses require a complete fertilizer containing nitrogen, phosphorous, and potassium. A fertilizer ratio of 3-1-2 is ideal. Warm-season grasses prefer slow-release fertilizer during the summer while cool-season grasses require fertilizer mostly in fall with some in spring.

2. Ask students if they irrigate their lawns. Ask how frequently they water.

   How are frequency and rate of irrigation determined?

   a) Dependent on soil type
   b) Dependent on grass type
   c) Dependent on temperature
   d) Dependent on growing season
   e) Dependent on root growth

3. Ask how many students mow their lawns. Ask how often they mow their lawns.

   When is the appropriate time to mow turfgrass?

   a) Dependent on grass type
   b) Dependent on fertilizer maintenance
   c) Dependent on watering

F. Other activities

1. Maintain school fields by mowing.
2. Maintain school fields by watering.
3. Maintain school fields by fertilizing.

G. Conclusion

Proper maintenance by fertilizing, mowing, and watering; will produce healthy turf. Fertility rates for warm- and cool-season grasses vary. A 3-1-2 ratio is recommended. Mowing heights are dependent on the kind of grass being cut. Usually one-third of the leaf blade is removed. An inch of water should be applied to the turf every seven to ten days.

H. Competency

Maintain turf by properly fertilizing, watering, and mowing.

I. Answers to Evaluation

1. b
2. c
3. a
4. b
5. d
6. b
7. c
8. c
9. c
10. c

J. Answers to Work Sheets

WS 3.1

1. L x W = area; 30 ft. x 15 ft. = 450 sq. ft.
2. L x W = area; 40 ft. x 5 ft. = 200 sq. ft.
3. Visualize it as a rectangle with a triangle on each end. Combine triangle A with C to make a rectangle or measure the two triangles and the rectangle separately. 45 ft. x 10 ft. = 450 sq. ft.
4. $\frac{\pi r^2}{2}$ = area of 1/2 circle
5. L x W = area; 40 ft. x 20 ft. = 800 sq. ft.
   $\frac{3.14 \times 15^2}{2}$ = 353.25 sq. ft.

WS 3.2

1. 145' x 85' = 12,325 sq. ft.
2. 30' x 77.5' = 2,325 sq. ft.
3. 35' x 15' = 525 sq. ft.
4. (D 25 x 20 = 500) + (W 25 x 5 = 125) = 625 sq. ft.
5. 25' x 30' = 750 sq. ft.
6. 12,325 - (2,325 + 525 + 625 + 750) = 8,100 sq. ft.
7. $\frac{8,100 \text{ sq. ft.}}{1} \times \frac{1 \text{ lb. N}}{1,000 \text{ sq. ft.}} \times \frac{100 \text{ lbs. fert.}}{21 \text{ lb. N}} = 38.57 \text{ lbs. fertilizer}$
8. $38.57 \text{ lbs. fert.} \times \frac{\$16.00}{50 \text{ lbs. fert.}} = \$12.35$

UNIT VIII - TURFGRASS

Name ____________________

Lesson 3: Turfgrass Maintenance

Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which essential element will stimulate vegetative growth in turf?

   a. Calcium
   b. Nitrogen
   c. Phosphorous
   d. Potassium

2. Which essential element will stimulate good root growth?

   a. Calcium
   b. Nitrogen
   c. Phosphorous
   d. Potassium

3. Which of the following ratios is advised for general turf fertilizer?

   a. 3-1-2
   b. 2-3-1
   c. 2-1-3
   d. 1-2-3

4. How is spray, liquid-feed fertilizer applied?

   a. By broadcasting
   b. By using a hose end proportioner
   c. By hopper feeder
   d. By spreader

5. When should warm-season grasses be fertilized?

   a. Autumn
   b. Early spring and late summer
   c. Early spring and midsummer
   d. Summer

6. Which of the following is not a factor for how often to water?

   a. Growing season
   b. Location of trees
   c. Soil type
   d. Temperature

7. In general, how deep will one inch of water wet the soil?

   a. To one inch
   b. To three inches
   c. To six inches
   d. To twelve inches

8. What is the ideal time to water?

   a. Afternoon
   b. Evening
   c. Morning
   d. Night

9. What is the recommended portion of leaf blade to be removed in mowing?

   a. one-eighth
   b. one-fourth
   c. one-third
   d. one-half

10. Which is not a characteristic of a reel mower?

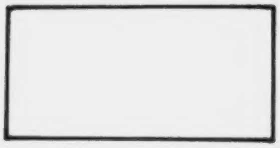
   a. Has no catcher
   b. Has scissors action
   c. Mows in a forward and backward movement
   d. Typically has five blades

Lesson 3: Turfgrass Maintenance

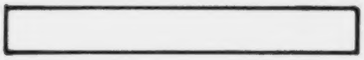
Work Sheet 3.1: Figuring Area for Fertilizer Application

Figure the area of the following shapes. Use a 1" = 20' scale. (Show your work.)

1.



2.



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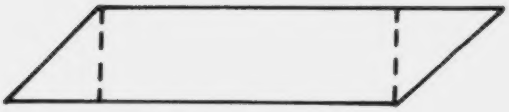

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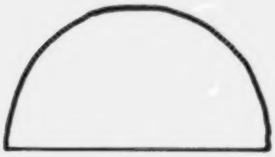
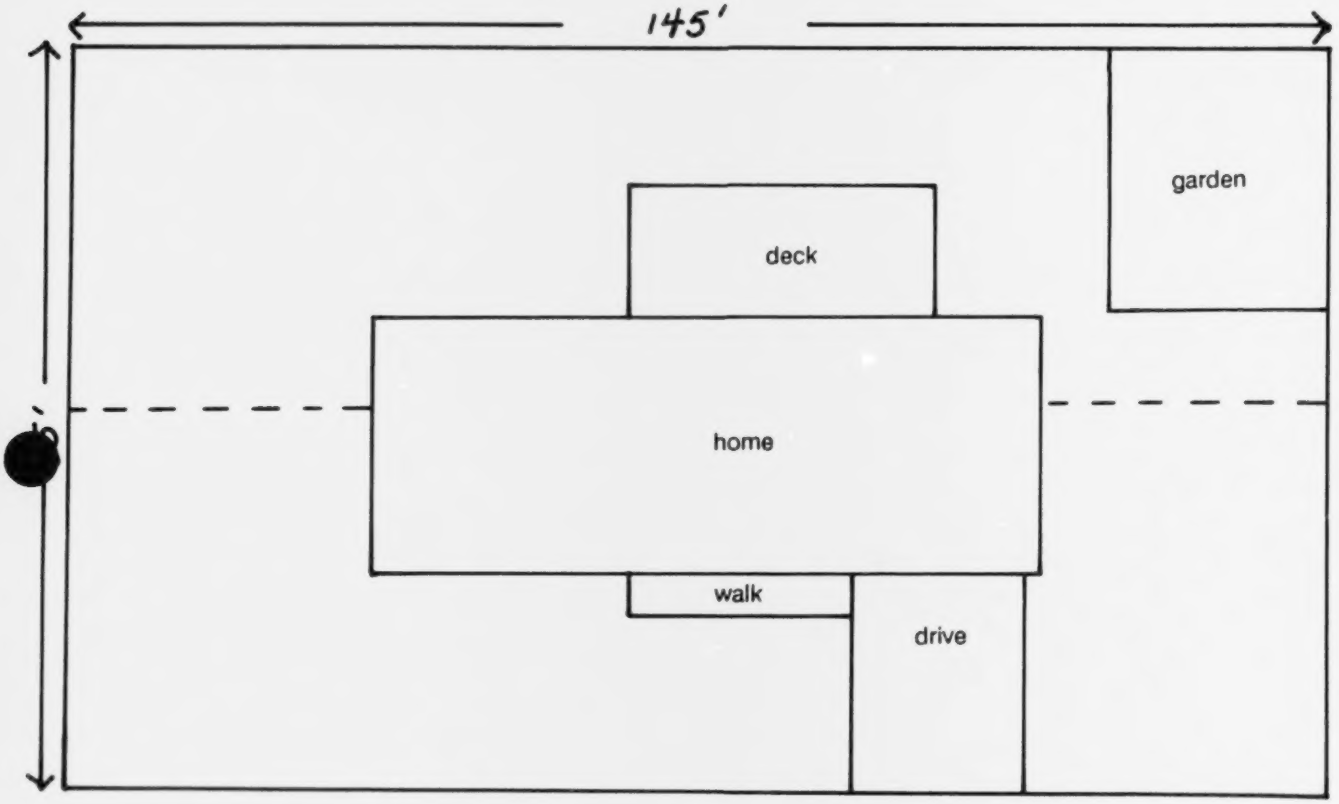


5.

Lesson 3: Turfgrass Maintenance

Work Sheet 3.2: Calculating Lawn Areas for Fertilizer Requirements

Calculate the areas as indicated to determine the amount of fertilizer required for the lawn. The scale is 1" = 20'.



1. What is the total area of the lot?

2. What is the area of the house?

3. What is the area of the deck?

4. What is the area of the drive and sidewalk?

5. What is the area of the garden?

6. By subtracting the area in questions 2, 3, 4 and 5 from the area of the lot (Q1), determine the area of the lawn.

7. How much 21-0-0 fertilizer would be needed to fertilize the lawn at a rate of one pound of nitrogen per 1,000 square feet?

8. If a fifty pound bag of 21-0-0 fertilizer costs $16., how much will it cost to fertlizer the lawn?

Lesson 3: Turfgrass Maintenance

Job Sheet 3.1: Spreader Calibrations

Objective: Upon completion of this job sheet, the student will be able to accurately calibrate a spreader.

Materials and Supplies Needed:

1. Spreader
2. Fertilizer, herbicide, or seed
3. Tape measure
4. Broom
5. Scale

Procedure:

1. Measure a square ten feet by ten feet. The area should be clean and smooth, such as a driveway or patio.

2. Fill the spreader with fertilizer, herbicide, or seed.

3. Spread the material to cover the ten by ten area.

4. Sweep and pick up the material that was spread in the square and weigh it.

5. Multiply the weight of the material times 100 to find the amount this particular calibration will spread over 1000 square feet.

6. If the amount is too much or not enough, change the calibration setting and repeat the procedure until the correct calibration is reached.

UNIT VIII - TURFGRASS

Lesson 4: Lawn Cultivation and Renovation

Objective: The student will be able to explain how to take a failing, established lawn and either cultivate or renovate it.

Study Questions

1. **What are some common reasons lawns fail?**
2. **What is thatch and how can it be controlled?**
3. **How can compacted soils be cultivated?**
4. **How can a lawn be renovated?**

Reference

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.

Lesson 4: Lawn Cultivation and Renovation

TEACHING PROCEDURES

A. Review

Review the previous lesson.

B. Motivation

Since cultivation and renovation can be large jobs, many homeowners hire a landscape maintenance company to complete them.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students if they have what they consider a perfect lawn. If not, ask what problems their lawn might have.

   What are some common reasons lawns fail?

   a) Disease
   b) Insects
   c) Weeds
   d) Drought
   e) Compaction
   f) Thatch

2. Discuss the fact that all plants grow and die. Ask students what happens to dead grass.

   What is thatch and how can it be controlled?

   Thatch is a layer of decomposing grass, leaves, and stems that lies below the leaf blades of a lawn, but above the soil. There are two primary ways of controlling thatch; controlling through prevention, and controlling through removal.

   a) Control through prevention
      1) Moderate and regular (but not excessive) fertilization to maintain good growth
      2) Regular mowing at recommended height
      3) Deep irrigation every 10-14 days during drought to promote deep root growth
      4) Annual raking before new flush of growth
      5) Coring to improve water and fertilizer penetration
      6) Top dressing to promote decomposition of thatch
   b) Control through removal
      1) Coring (aerification)
      2) Spiking
      3) Slicing
      4) Vertical mowing

        5) Raking

3. Ask students why turf does not grow very well on baseball, soccer, and football fields.

   How can compacted soils be cultivated?

   a) Water the day before if necessary.
   b) Remove small cores.
   c) Topdress the area.

4. Ask students how they would repair a weak or damaged lawn.

   How can a lawn be renovated?

   a) Remove all weeds and damaged turf in the area to be renovated.
   b) Verticut the rest of the lawn.
   c) Aerate the soil.
   d) Add topsoil to change grade.
   e) Rake for final grade.
   f) Incorporate lime and fertilizers.
   g) Sow seed, sprig, plug, or sod.

F. Other activities

   1. Dethatch fields on school grounds.

   2. Renovate fields on school grounds.

   3. Test different areas for thatch.

G. Conclusion

If turfgrass is not properly cultivated it can develop a variety of problems, such as thatch or compaction. These problems can be remedied by performing proper maintenance procedures. These include: adequate watering, fertilizing, and mowing. In some cases where deterioration is too extreme for repair, renovation or replanting turf is necessary.

H. Competency

Explain how to successfully cultivate or renovate a lawn.

I. Answers to Evaluation

   1. c
   2. b
   3. d
   4. a
   5. c
   6. a
   7. a
   8. d

Name ______________

Lesson 4: Lawn Cultivation and Renovation

Date ______________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which best defines cultivation?

   a. Cultivating new plants
   b. Mechanical removal of insects
   c. Mechanical removal of thatch
   d. Using proper cultivation practices

2. Which is not included in renovation?

   a. Cultivation
   b. Moving the entire turf to another area
   c. Reseeding and replanting
   d. Turf improvement

3. What is a layer of decomposing grass found between the grass blades and the soil layer called?

   a. Cultivation
   b. Penetration
   c. Renovation
   d. Thatch

4. Which is not a cause of thatch?

   a. Lawn clippings
   b. Excessive growth
   c. Over fertilization
   d. Prolonged drought

5. Which is an example of a cultural practice to help prevent thatch?

   a. Mow tall
   b. Overfertilizing
   c. Fertilize with modest amounts of nitrogen
   d. Underwatering

6. When should cool-season grasses be dethatched?

   a. Autumn
   b. Early summer
   c. Late summer
   d. Winter

7. Which results in the most aeration of a lawn.

   a. Coring
   b. Spiking
   c. Splicing
   d. Vertical mowing

8. How often is vertical mowing recommended?

   a. Every year
   b. Every 2 years
   c. Every 4 years
   d. Depends on rate of thatch build up

UNIT VIII - TURFGRASS

Lesson 5: Pest Identification and Control

Objective: The student will be able to identify common weeds, insects, and diseases that damage the turf; and explain how these pests are controlled.

Study Questions

1. **Why do pests develop in a lawn?**
2. **What are ten broadleaf and grassy turfgrass weeds?**
3. **What steps should be taken to control turfgrass weeds?**
4. **What are the different turfgrass diseases that occur in Missouri during spring, summer, and autumn?**
5. **What steps should be taken to control turfgrass diseases?**
6. **What are the two most common turfgrass insects?**
7. **What steps should be taken to control turfgrass insects?**

Reference

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.

Lesson 5: Pest Identification and Control

TEACHING PROCEDURES

A. Review

Review previous lesson.

B. Motivation

Explain that insects, diseases, and weeds can totally destroy a lawn. Early identification of pests can prevent extensive damage to the turf and, therefore, save money.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students if they have weeds in their lawns.

   Why do pests develop in a lawn?

   Results of poor cultural management

2. Ask students who have weeds in their lawns if they can identify any of the weeds.

   What are ten broadleaf and grassy turfgrass weeds.

   a) Crabgrass
   b) Plantain
      1) Broadleaf
      2) Buckhorn
   c) White Clover
   d) Dandelion
   e) Nutsedge
   f) Henbit
   g) Prostrate spurge
   h) Curly dock
   i) Common chickweed
   j) Wild onion

3. Ask students if any have tried to control weeds in their lawns and how they controlled them.

   What steps should be taken to control turfgrass weeds?

   a) Nonchemical control - appropriate cultural management practices
   b) Chemical control
      1) Preemergence herbicides - applied to soil before weeds germinate
      2) Postemergence herbicides - applied to weeds when they are actively growing
      3) Selective herbicides - kills some weeds but not others

        4) Nonselective herbicides - kills all plants

4. Ask students if they have had any diseases in their lawns.

   What are the different turfgrass diseases that occur in Missouri during spring, summer, and autumn?

   a) Snow mold - late winter and early spring
   b) Pythium blight - summer
   c) Fairy rings - spring, summer, and autumn
   d) Dollar spot - spring, summer, and autumn
   e) Fusarium blight - summer
   f) Brown patch - summer

5. Ask students if they have tried to control diseases and how they controlled them.

   What steps should be taken to control turfgrass diseases?

   a) Nonchemical control
      1) Planting grasses with high disease resistance
      2) Using proper cultural management practices
   b) Chemical control-fungicides
      1) Systemic
      2) Nonsystemic

6. Ask students if they have had problems with insects in their lawns. Ask students to identify which insects caused the problems.

   What are the two most common turfgrass insects?

   a) White grubs
   b) Sod webworms

7. Ask students if they have had problems with insects and how they controlled them.

   What steps should be taken to control turfgrass insects?

   Nonchemical (dethatching) and chemical control should be used together.

F. Other activities

1. Take students outside on school grounds to identify weeds, to detect and identify diseases, and to detect and identify insects.

2. Make a weed collection of those weeds listed in the student's reference.

G. Conclusion

Weeds, diseases, and insects occur in turf mainly as a result of poor cultural management practices; and can be controlled by either chemical or nonchemical practices.

H. Competency

Identify common pests in turfgrass and explain how to control these pests.

I. Answers to Evaluation

1. b
2. c
3. d
4. d
5. a
6. d
7. b
8. a
9. d
10. b

Name ____________

Lesson 5: Pest Identification and Control

Date ____________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which is the "king" of grassy weeds?

   a. Buckhorn plantain
   b. Crabgrass
   c. Henbit
   d. Wild onion

2. Which of the following is a broadleaf perennial weed with a fleshy taproot and yellow flower?

   a. Clover
   b. Crabgrass
   c. Dandelion
   d. Nutsedge

3. Which of the following weeds oozes a white, milky sap?

   a. Broadleaf plantain
   b. Common chickweed
   c. Curly dock
   d. Prostrate spurge

4. Which of the following weeds has a strong odor?

   a. Curly dock
   b. Dandelion
   c. Henbit
   d. Wild onion

5. Which of the following herbicides will kill any plant that it contacts?

   a. Nonselective
   b. Postemergence
   c. Preemergence
   d. Selective

6. Which of the following diseases thrives at or near freezing temperatures?

   a. Brown patch
   b. Fairy rings
   c. Pythium blight
   d. Snow mold

7. Which of the following diseases has mushrooms or puffballs?
   a. Dollar spot
   b. Fairy rings
   c. Fusarium blight
   d. Snow mold

8. Which of the following diseases mainly attacks tall fescue?
   a. Brown patch
   b. Dollar spot
   c. Fairy rings
   d. Snow mold

9. Which of the following move within the the plant as a preventative measure for diseases?
   a. Nonselective herbicides
   b. Nonsystemic fungicides
   c. Preemergence herbicides
   d. Systemic fungicides

10. How many white grubs per square feet does it take to indicate need for eradication?
    a. Two
    b. Seven
    c. Fifteen
    d. Fifty

UNIT IX - SITE ANALYSIS AND EVALUATION

Lesson 1: Introduction to Landscape Design

Objective: The student will be able to analyze a landscape site.

Study Questions

1. **What is meant by landscape design?**
2. **What is the purpose of a landscape design?**
3. **What do the terms site, on-site, and off-site mean?**
4. **What factors should be considered when preparing a landscape design?**
5. **What are the three major use areas of a landscape design?**
6. **What does a landscape designer need to know about zoning regulations?**

References

1. Landscaping and Turf Management. (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
2. Work Sheet
    a) WS 1.1: Calculating Slope
3. Job Sheet
    a) JS 1.1: Site Analysis and Family Needs Checklist

UNIT IX - SITE ANALYSIS AND EVALUATION

Lesson 1: Introduction to Landscape Design

TEACHING PROCEDURES

A. Review

Review previous lesson.

B. Motivation

Before a landscape can be designed, the site must be evaluated. Some plants on the site may need to be removed while others can be used in the new landscape plan. Using existing plants will save money for the homeowner or client.

C. Assignment

D. Supervised study

E. Discussion

1. Ask the students to define a landscape design.

   What is meant by landscape design?

   Landscape design is an art combined with practical science that produces a unified, working composition.

2. Ask students why they think a landscape design is important.

   What is the purpose of a landscape design?

   Landscape design is the written and drawn form of communication between the designer and client. It is important in showing interrelationships of the areas of the design. Written and drawn ideas have less chance of being forgotten.

3. Ask students to give definitions of site, on-site, and off-site.

   What do the terms site, on-site, and off-site mean?

   a) Site - an area to be, designed, installed, and maintained
   b) On-site - any vegetation, features, and buildings already existing on the area
   c) Off-site - any vegetation, features, and buildings existing within sight or sound of the area, but not located on the area; e.g., highway, trash area, and trees

4. Ask students what questions are important to ask a client before the actual design process begins. Have students complete WS 1.1. The site analysis and analysis of family needs are discussed more in unit XI, Lesson 5.

   What factors should be considered when preparing a landscape design?

   a) Site analysis - any information about the physical site

b) **Analysis of family needs** - how a family's desires can be considered in the landscape plan in order to meet personal needs

5. Ask students what rooms exist in their homes. Ask students what "rooms" might exist in a landscape design.

   What are the three major use areas of a landscape design?

   a) Public area - part of site open to public view at all times
   b) Private area - part of site intended for private use
   c) Service area - part of site for utility or work

6. Ask students to define zoning regulations.

   What does a landscape designer need to know about zoning regulations?

   Zoning regulations are important to know before any construction is planned or additions are made in a landscape. The purpose of these regulations is public safety. The regulations can be obtained from the local city hall.

F. Other activities

1. Have students site-analyze the classroom.

2. Have students "interview" potential clients using a checklist.

3. Invite someone from city hall to visit the classroom and explain zoning regulations.

G. Conclusion

Analyzing the site is a step in the process of designing the landscape. Knowing what is already present on a site and the needs of the client are important to analysis. A landscape design usually includes three use areas. A designer must be aware of local zoning regulations.

H. Competency

Analyze a landscape site.

I. Answers to Evaluation

1. c
2. b
3. b
4. c
5. d

6. Answers may include three of the following:
   a) Terrain
   b) Vegetation, house; other buildings and objects on-site
   c) Regional factors
   d) Zoning regulations
   e) Location of utilities
   f) Off-site features
   g) Directions of prevailing seasonal winds

    h) Location of North in relation to site

7. Answers may include three of the following:
    a) Age, sex, and hobbies of each family member
    b) Personal plant preferences
    c) Amount of time available for maintenance
    d) Whether home is permanent or temporary residence
    e) Location of service areas
    f) Additions to existing buildings; decks, patios, or a swimming pool

J. Answers to Work Sheet

W.S. 1.1

1. a) $\frac{12}{50} \times 100 = 24\%$

    b) Plant groundcovers and/or shrubs on bank.

2. a) $\frac{6}{75} \times 100 = 8\%$

    b) Yes

3. a) $\frac{18}{40} \times 100 = 45\%$

    b) Steps or terracing will be required.

4. a) $\frac{1}{17} \times 100 = 6\%$ (5.88)

    b) No

Name ____________________

Lesson 1: Introduction to Landscape Design

Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. What is the definition of landscape design?
   a. An art
   b. A practical science
   c. Combination of an art and practical science
   d. Elements and principles

2. What is the term for any vegetation, buildings, or objects existing within sight or sound of site?
   a. Near-site
   b. Off-site
   c. On-site
   d. Site

3. Where is the public use area usually located?
   a. In the back yard
   b. In the front yard
   c. In the side yard
   d. Near the driveway

4. Which use area is also considered the utility area?
   a. Private
   b. Public
   c. Service
   d. None of the above

5. Which is true of zoning regulations?
   a. Are the same for each state
   b. Are the same for each town
   c. Differ for each home
   d. Differ for each town

Complete the following short answer questions.

6. What are three factors that should be considered in a site analysis?

   a.

   b.

   c.

7. What are three factors that should be considered for analysis of family needs?

a.

b.

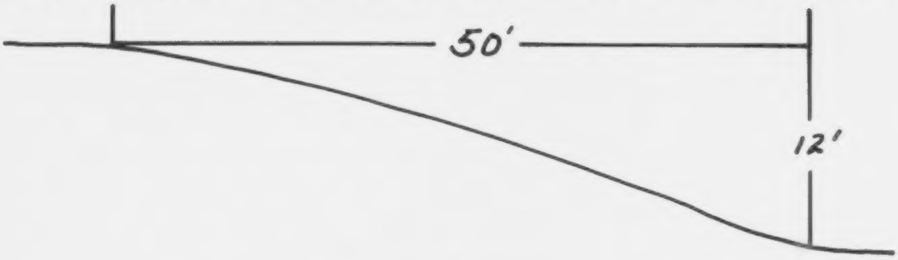
c.

Lesson 1: Introduction to Landscape Design

Work Sheet 1.1: Calculating Slope

Calculate the percentage of slope and answer the questions for the following. (Show your work.)

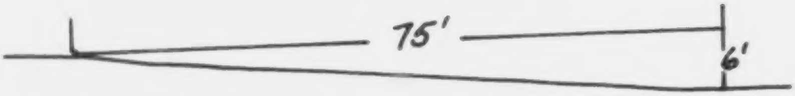
1.



a) Percentage of slope

b) What is the suggested landscape use for this slope?

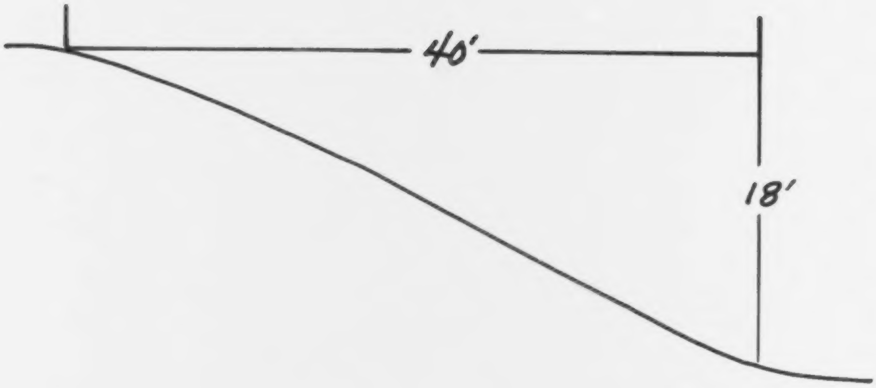
2.



a) Percentage of slope

b) Is this slope suitable for a drive?

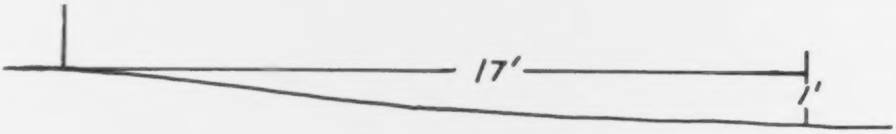
3.



a) Percentage of slope

b) What is the suggested landscape use for this slope?

4.



a) Percentage of slope

b) Is this slope suitable for a patio?

Lesson 1: Introduction to Landscape Design

Job Sheet 1.1: Site Analysis and Family Needs Checklist

Objective: Upon completion of this job sheet, the student will be able to interview a potential client with a site analysis checklist and family needs checklist.

Materials and Supplies Needed:

1. Site analysis checklist
2. Family needs checklist
3. Pencil
4. Potential client
5. Site

Procedure:

1. If necessary, call client for appointment.
2. Interview client with family needs checklist.
3. Analyze site with site analysis checklist.
4. Roughly sketch site in space provided below.

UNIT IX - SITE ANALYSIS AND EVALUATION

Lesson 2: Drawing a Base Map

Objective: The student will be able to accurately measure a landscape site and draw a base map to scale.

Study Questions

1. **What information is provided on a base map?**
2. **How are structures located on a base map?**
3. **What tools and equipment are needed to draw a base map?**
4. **What types of scales can be used on a base map?**

References

1. Landscaping and Turf Management (Student Reference)., University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
2. Job Sheets
    a) JS 2.1: Measuring a Site
    b) JS 2.2: Drawing a Base Map

UNIT IX - SITE ANALYSIS AND EVALUATION

Lesson 2: Drawing a Base Map

TEACHING PROCEDURES

A. Review

Review previous lesson. Review measuring techniques.

B. Motivation

Before any landscape plan can be drawn or designed, measurements are necessary. Accurate and proper measurements will help ensure a successful placement of elements in a landscape design.

C. Assignment

D. Supervised study

E. Discussion

1. Ask the students what features might be found on a landscape site.

What information is provided on a base map?

A base map includes any information gained by a site analysis; such as existing buildings,north direction arrow, and vegetation.

2. Ask students how they are able to find cities and distances between cities on a map.

How are structures located on a base map?

Using graph paper, orient the map to existing road or boundary lines; then step-off or measure existing features of the site, and draw them in.

3. Ask students what tools and equipment are needed for painting a picture or making a drawing; then ask which of these tools could be used for drawing a base map.

What tools and equipment are needed to draw a base map?

a) Primary tools and equipment
    1) Pencil (sharp, fine lead, number two)
    2) Tracing paper or graph paper - 11" x 17" suggested
    3) Drafting tape
    4) Sketch paper or pad
    5) Eraser
b) Supportive drawing equipment
    1) Drawing table or drafting board
    2) T-square or parallel rule
    3) Triangles
    4) Templates
    5) Lettering guides

4. Ask students what kinds of scales can be used for measuring.

What types of scales can be used on a base map?

a) Architect's scale
b) Engineer's scale
c) Metric scale

F. Other activities

1. Have students determine their natural stride (step-off).

2. Have students practice using an architect's scale.

G. Conclusion

In order to design a landscape, the site must be accurately measured and drawn to scale on a base map.

H. Competency

Draw a base map to scale.

I. Answers to Evaluation

1. Answers should include five of the following:
north arrow
utility line location
existing vegetation, buildings, and features
sunrise and sunset positions
good views and poor views
measurements

2. Answers should include five of the following:
pencils
tracing paper or graph paper
drafting tape
sketch paper or pads
drawing table or drafting board
T-square or parallel rule
triangles
templates
lettering guides

3. The instructor needs to determine if this was completed satisfactorily.

UNIT IX - SITE ANALYSIS AND EVALUATION

Name ____________________

Lesson 2: Drawing a Base Map

Date ____________________

EVALUATION

Complete the following short answer questions.

1. List five items that can be found on a base map.

   a.
   b.
   c.
   d.
   e.

2. List five tools or pieces of equipment used in drawing a base map.

   a.
   b.
   c.
   d.
   e.

3. If you have not completed JS 2.1 and 2.2, check with your instructor about completing them at this time.

Lesson 2: Drawing a Base Map

Job Sheet 2.1: Measuring a Site

Objective: Upon completion of this job sheet the student will be able to measure a site with accuracy.

Materials and Supplies Needed:

1. Tape measure
2. Paper and pencil
3. Site - to be determined by teacher

Procedure:

1. Work in pairs.
2. Roughly sketch the site on a separate sheet of paper, writing in the measurements. Be sure to measure in feet and inches.
3. Measure the dimensions, both length and width of the property boundaries of the site.
4. Measure the dimensions of the house and any other buildings on the property.
5. Measure the distance from the house to the property boundaries by locating a corner of the house. See Figure 1.1. If the house is not parallel to property lines, locate two corners of the house. See Figure 1.2.
6. Measure all existing traffic patterns (sidewalks, driveways, pathways, etc.) in location to the house.
7. Measure existing vegetation or garden areas from a well-established point, such as from the house. Trees and shrubs should be measured from their centers. Indicate names of plants, if known. See Figure 1.3.
8. Measure any existing slope.
9. Measure base and heights of windows and doorways of house and put measurements on a separate sheet of paper for future reference. Roughly sketch the placement of windows and doorways.

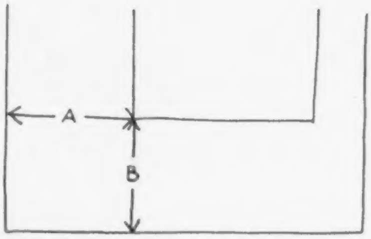


Figure 1.1

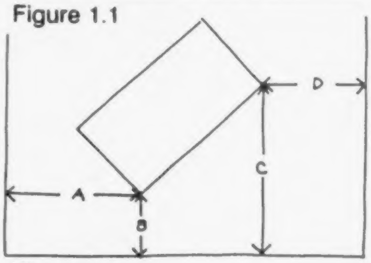


Figure 1.2

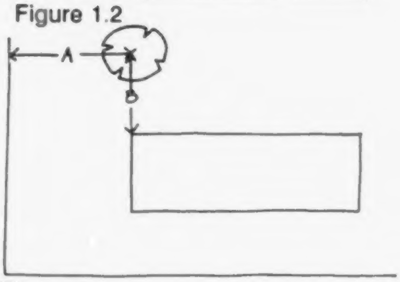


Figure 1.3

Lesson 2: Drawing a Base Map

Job Sheet 2.2: Drawing a Base Map

Objective: Upon completion of this job sheet the student will be able to draw a base map.

Materials and Supplies Needed:

1. Pencil and eraser
2. Graph paper - 11 x 17 is suggested
3. Ruler
4. Measurements and notes from JS 2.1

Procedure:

1. Draw the measurements taken from JS 2.1 to scale using a 1/10 scale. Be sure to make the base map structures as large as possible to fit the piece of paper.
2. Draw property boundaries first.
3. Next draw the house using one or two corners of the house to accurately place it on the property. Make the house dimensions with a thicker line than the boundary line. See Figure 2.1.
4. Draw in windows and doorways of the house. See Figure 2.2.
5. Draw traffic patterns from a well-established point.
6. Draw in any vegetation from a well-established point.
7. Add any helpful notes or information to the base map.

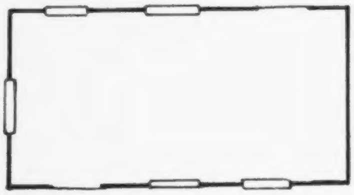


Figure 2.1

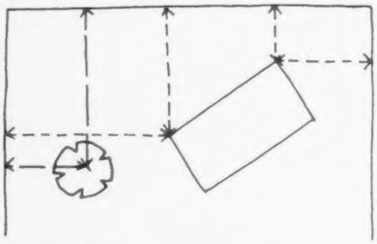


Figure 2.2

UNIT IX - SITE ANALYSIS AND EVALUATION

Lesson 3: Interpreting a Landscape Plan

Objective: The student will be able to effectively use symbols on a landscape plan.

Study Questions

1. **What are the major features on a landscape plan?**
2. **What information is used in a title block?**
3. **What additional types of drawings are used to illustrate a landscape plan to the client?**

References

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
2. Work Sheet
    a) WS 3.1: Title Blocks

Lesson 3: Interpreting a Landscape Plan

TEACHING PROCEDURES

A. Review

Review Unit IX, Lesson 2.

B. Motivation

A clean, concise landscape plan effectively represented with symbols will help sell a landscape design. It will communicate to the client exactly what the landscape designer's ideas are.

C. Assignment

D. Supervised study

E. Discussion

1. Ask the students to list typical symbols seen daily, such as stop signs. Ask students what features of a landscape plan might need a symbol.

   What are the major features on a landscape plan?

   a) Design symbols
      1) Variations of circles
         (a) Deciduous trees
         (b) Evergreen trees
      2) Variations of lines
      3) Written scale
      4) Directional indicator
   b) Plant list
   c) Letterings
   d) Title block

2. Ask students what information is found in a legend of a map.

   What information is used in a title block?

   a) Title of the project
   b) Name of client
   c) Address of property designed
   d) Name or initials of designer or company
   e) Date design was completed
   f) Scale used
   g) Directional indicator

3. Ask students how else a designer might communicate ideas to the client.

   What additional types of drawings are used to illustrate a landscape plan to a client?

   a) Elevational drawing
   b) Perspective view drawing
   c) Construction-detail drawing

F. Other activities

1. Have students practice drawing design symbols.

2. Have students practice placing and filling in title blocks.

3. Have students practice lettering, with emphasis on legibility.

G. Conclusion

Design symbols and a title block on the landscape plan are important data that communicate the designer's ideas to a potential client.

H. Competency

Effectively use design symbols in a landscape plan.

I. Answers to Evaluation

1. b
2. a
3. d
4. a
5. c

6. Answers should include three of the following: botanical name; size; quantity; conditions of plants; client's name.

7. Answers should include three of the following: title of project; designer's initials; name of landscape firm; date plan was completed; address of property.

8. up to the teacher's discretion

J. Answers to WS 3.1 - up to the teacher's discretion

UNIT IX - SITE ANALYSIS AND EVALUATION

Name ____________________

Lesson 3: Interpreting a Landscape Plan

Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Variations of what symbol represent ground cover?

   a. Circle
   b. Color
   c. Lettering
   d. Line

2. What do symbols represent in landscape designs?

   a. Drawings of overhead views of features
   b. Exact placements
   c. Perspective view drawings
   d. Title blocks

3. Which of the following is not a symbol?

   a. Directional indicator
   b. Lettering
   c. Lines
   d. Title block

4. Which of the following is the most common method of lettering?

   a. Freehand
   b. Lettering guides
   c. Lettering tape machine
   d. Waxed press-on letters

5. Which of the following is not a type of drawing used to illustrate a landscape plan?

   a. Construction-detail drawing
   b. Elevational drawing
   c. Landscape method drawing
   d. Perspective view drawing

Complete the following short answer questions.

6. What are three items found in a plant list?

   a.
   b.
   c.

7. What are three items found in the title block?

   a.
   b.
   c.

8. Draw a common symbol for each of the following:

   a. Deciduous tree

   b. Evergreen tree

Lesson 3: Interpreting a Landscape Plan

Work Sheet 3.1: Title Blocks

Add the following information in block title form to your base map drawing (JS 2.2).

1. Scale of drawing
2. Owner's name
3. Property address
4. North directional arrow
5. Date
6. Title of the project
7. Name or initials of designer or company

UNIT X - SELECTING AND USING PLANTS IN THE LANDSCAPE

Lesson 1: Selecting Trees for the Landscape

Objective: The student will be able to describe the purposes of trees in the landscape and factors considered in selecting trees.

Study Questions

1. **What are the purposes of trees in the landscape?**
2. **What should be considered when selecting trees for the landscape?**
3. **What are the selection criteria for common trees?**

Reference

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.

UNIT X - SELECTING AND USING PLANTS IN THE LANDSCAPE

Lesson 1: Selecting Trees for the Landscape

TEACHING PROCEDURES

A. Introduction

Since trees are the largest and most dominant element in a landscape, appropriate selection is extremely important. A landscaper must be able to select trees according to the theme of the design, functions required, and personal desires of the client.

B. Motivation

Explain that trees are the most permanent element in the landscape and that their selection is important to the theme of the design. The tree selected should fulfill the purpose intended.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students to think of ways they have seen trees used in the landscape.

   What are the purposes of trees in the landscape?

   a) Climatic Effects
      1) Help purify air
      2) Reduce noise levels
      3) Help control erosion
      4) Increase or decrease wind
      5) Cool air through transpiration
      6) Provide shade, reducing room and ground temperature, and blocking direct rays from sun
      7) Obstruct, deflect, and filter air flow for the benefit of small plants, animals, and property
   b) Aesthetics
      1) Ceiling for an outdoor room
      2) Create feeling of intimacy
      3) Variety of colors, forms, textures, and patterns
      4) Frame and accentuate design and structure detail of a house
      5) Soften or complement architectural lines
      6) Provide welcoming effect for an entrance
      7) Frame views, provide focal points, and form vistas
      8) Spark up monotony of pavement and masonry
      9) Provide play areas
      10) Provide shade
      11) Screen out unsightly views
      12) Provide privacy
      13) Provide flowery fragrances, peaceful sounds
      14) Provide a flowering, focal point
      15) Provide seasonal variety

        16) Help new residences look established
        17) Provide backdrop for other plant material
        18) Attract birds
    c) Economic value - increase property value
    d) Psychological effect
        1) Increase social activity
        2) Promote good community relations
        3) Increase productivity and lower absenteeism in industry
    e) Purposes of deciduous trees
        1) Seasonal changes of color, line, texture, and pattern
        2) Energy conservation
            (a) Shade in summer
            (b) Planting only deciduous plants on south side of house so in the winter sun's rays can filter through and help heat house
    f) Purposes of evergreens
        1) As screens, sound barriers, to provide privacy, and as backdrops for other plantings
        2) On north side of house, keeps winds from reducing heat inside house
        3) Only slight, seasonal color change
        4) May produce flowers and fruits

2. Ask students to think about what they should know about a tree before selecting it for landscape.

What should be considered when selecting trees for the landscape?

    a) Location
    b) Purpose of tree
    c) Avoidance of:
        1) Those susceptible to storm damage
        2) Those with weak wood
        3) Those susceptible to pests and diseases
        4) Those that produce unwanted seeds or fruit
    d) Existing conditions
        1) Room for top and root growth
        2) Soil type
        3) pH
        4) Subsurface drainage
        5) Amount of available light
    e) Plant characteristics
        1) Hardiness of plant and hardiness zone of location
        2) Height at maturity
        3) Width at maturity
        4) Form
        5) Growth habit
        6) Branching habit
        7) Rate of growth
        8) Water, light, fertilization, and temperature requirements
        9) Leaf color (in all seasons)
        10) Flower color, type, and time of bloom
        11) Fruit type, color, and time of production
        12) Texture
        13) Disease, insect problems, and control methods
        14) Pruning requirements

    15) Ability to be transplanted
    16) Life span
    17) Availability
    18) Function in landscape
    19) Salt tolerance
    20) Spacing
    21) Maintenance
e) Considerations in selecting street trees
    1) Ability to permit free pedestrian and traffic movement
    2) Ability to avoid interference with overhead or underground utility installation
    3) Ability to avoid interference of traffic sighting distance
    4) Ability to provide desired shade and appearance
    5) Suitability to available space
    6) Hardiness and maintenance requirements

3. Take the class on a field trip to see how trees are used in the landscape. Ask the students to critique the landscape using the information in the charts as a basis for the correct use of trees. Have them tell if the tree is or is not an appropriate choice and why. If it is not, ask what would be a better choice. Have the students continue filling out the work sheet started in Unit III.

NOTE: All tree selection tables are in the student reference.

What are the selection criteria for common trees?

a) Shade trees
    1) Acer rubrum - red maple
    2) Acer saccharum - sugar maple
    3) Betula nigra - river birch
    4) Betula pendula - European white birch
    5) Fraximus Pennsylvania - green ash
    6) Gleditsia triacanthos var. inermis - thornless honey locust
    7) Liquidamba styraciflua - sweet gum
    8) Liriodendron tulipifera - tulip tree
    9) Platanus occidentalis - sycamore
    10) Quercus palustria - pin oak
    11) Tilia cordata - little leaf linden
b) Flowering trees
    1) Albizia julibrissin - mimosa
    2) Cercis canadensis - eastern redbug
    3) Cornus florida - flowering dogwood
    4) Crataegus phaenopyrum - Washington Hawthorne
    5) Koelreuteria paniculata - golden raintree
    6) Magnolia soulangiana - saucer magnolia
    7) Malus species - flowering crabapple
    8) Pyrus calleryana 'Bradford' - Bradford pear
c) Evergreen trees
    1) Ilex opaca - American holly
    2) Juniperus virginiana - canart juniper
    3) Magnolia grandiflora - southern magnolia
    4) Picea abies - Norway spruce
    5) Picea pungens glauca var. - blue spruce
    6) Pinus nigra - Austrian pine
    7) Pinus strobus - white pine

8) Pinus sylvestris - Scotch pine
9) Tsuga canadensis - hemlock

F. Other activity

Have the students select a location to plant a tree (on the school campus). Then have them select a tree that would suit the chosen location based on information found in the lesson. Have them plant their selection (obtain plants from local nursery/garden center).

G. Conclusion

Trees perform various functions in a landscape. Trees add climatic, aesthetic, economic, and psychological value to a landscape. Criteria such as location, purpose, existing conditions, and plant characteristics should be considered before selecting a tree. Each tree has unique characteristics which help determine if the tree will be a good choice.

H. Competency

Select trees for specific purposes in the landscape.

I. Answers to Evaluation

1. b
2. a
3. d
4. c
5. d
6. d
7. Up to instructor's discretion

UNIT X - SELECTING AND USING PLANTS IN THE LANDSCAPE Name ______________

Lesson 1: Selecting Trees for the Landscape Date ______________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Ted wants to plant a tree in his mother's yard for a Mother's Day gift. Which of the following should not be a consideration before planting the tree?

    a. Existing conditions in planting location such as soil type, pH, drainage, and amount of light available
    b. If it is a fast growing tree which will quickly fill in space
    c. Location and purpose the tree will serve
    d. Plant characteristics such as height to expect at maturity, soil preference, form, growth habit, and water requirements

2. The following characteristics belong to which tree? It is used for quick shade, has winged seeds for fruit, is drought resistant, and Marshall's seedless is a cultivar.

    a. Green ash
    b. Honey locust
    c. Littleleaf linden
    d. Red maple

3. What is the Missouri State Tree, which is an understory tree growing to less than 25 feet, and blooming in the early spring with white flowers?

    a. Bradford pear
    b. Eastern redbud
    c. Flowering crabapple
    d. Flowering dogwood

4. Of the three pine trees studied, which one is a poor choice as an ornamental tree because of nematode problems?

    a. White pine
    b. Austrian pine
    c. Scotch pine
    d. None of the above

5. What is a narrow-leaf evergreen tree, used as an understory tree; that should be planted on a north exposure, does not like dry winds or prolonged heat, and gets sun scorch in temperature over 95° F?

    a. Austrian pine
    b. Blue spruce
    c. Eastern red cedar
    d. Hemlock

6. What is a hardy tree that grows to 70 feet, has exfoliating bark, tolerates many soils including alkaline, can tolerate city conditions; but should not be used there since it has messy, prickly balls that remain on the tree after the leaves fall and drop periodically during the winter?

   a. Tulip tree
   b. Sugar maple
   c. Sweet gum
   d. Sycamore

Complete the following short answer question.

7. What are five purposes trees serve in the landscape?

   a.

   b.

   c.

   d.

   e.

UNIT X - SELECTING AND USING PLANTS IN THE LANDSCAPE

Lesson 2: Selecting Shrubs and Hedges for the Landscape

Objective: The student will be able to select shrubs or hedges to fulfill desired purposes in a landscape plan.

Study Questions

1. **What are the purposes of shrubs and hedges in the landscape?**
2. **What should be considered when selecting shrubs and hedges for the landscape?**
3. **What are the selection criteria for common shrubs?**

Reference

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.

UNIT X - SELECTING AND USING PLANTS IN THE LANDSCAPE

Lesson 2: Selecting Shrubs and Hedges for the Landscape

TEACHING PROCEDURES

A. Review

Review previous lesson. Review Unit III, Lesson 5.

B. Motivation

With the wide range of sizes, shapes, and varieties of shrubs; the selection process becomes a very important step in landscape design. Proper selection offers effective transition from trees and structures to ground, as well as fulfills various other purposes desired in a landscape plan.

C. Assignment

D. Supervised study

E. Discussion

1. Ask the students if they have shrubs or hedges in their yards. Have them describe where they are in the landscape and if they know why they were placed there. Ask them if they know the purposes of having shrubs or hedges.

What are the purposes of shrubs and hedges in the landscape?

a) Shrubs
    1) Wall element in outdoor room
    2) Enclose spaces
    3) Define spaces
    4) Transition plant from trees and structures to ground
    5) Specimen or accent plant
    6) Privacy and security - should be six feet tall, wide and dense
    7) Screen
    8) Help direct traffic
    9) Focal point and seasonal effects
    10) Soften harsh building lines
    11) Absorb noise and serve as a windbreak
    12) Air purifier

b) Hedges
    1) Fence or screen for privacy
    2) Low hedge (one foot or less) - border for flower beds and walks
    3) Medium hedge (up to six feet)
        (a) Property border
        (b) Backdrop for other plants
    4) Tall hedge (over six feet)
        (a) Helps block wind and sun
        (b) Screens unsightly objects or views

2. Ask the students if they were going to plant a shrub in their yard what would they want to know about the shrub and the location before planting. Ask them if the size or form of shrub would matter, or if the acidic soil or shade at the location would matter.

   What should be considered when selecting shrubs and hedges for the landscape?

   a) Criteria listed for selection of trees
   b) Texture
      1) Fine-textured shrubs
         (a) Spaces appear larger
         (b) Good backdrop for flowers
      2) Coarse-textured shrubs
         (a) Better for large spaces
         (b) Attract attention - counterbalance with more fine-textured plants
   c) Size - varies widely, determination of mature size
   d) Broad-leaved evergreens - reflect light making them look lighter in weight
   e) Narrow-leaved evergreens
      1) Absorb light making them look heavy in weight
      2) Care must be used when planting with deciduous shrubs
   f) Deciduous shrubs - winter stem colors vary
   g) Consider mature form - pruning requires high maintenance
   h) Formal or informal landscape - must be determined before selection

3. Take the class on a field trip to see how shrubs and hedges are used in a landscape. Ask the students to critique the landscape using the information in the charts as a guide. Have them tell if the shrub or hedge is or is not the correct choice for the location and why. If it is not, ask them for alternative choices. Have the students continue filling out the work sheet started in Unit III.

   NOTE: All shrub selection tables are in the student reference

   What are the selection criteria for common shrubs?

   a) Flowering Shrubs
      1) Berberis thunbergii - Japanese barberry
      2) Cornus sericea - redosier dogwood
      3) Chaenomeles speciosa - flowering quince
      4) Euonymus alatus - winged euonymus
      5) Forsythia x intermedia - border forsythia
      6) Ligustrum japonicum - wax leaf privet
      7) Nandina domesticum - nandina
      8) Pyracantha coccinea - scarlet firethorn
      9) Salix gracilistyla - rosegold pussywillow
      10) Spirea vanhouttei - Vanhoutte spirea
      11) Syringa vulgaris - common lilac

   b) Evergreen Shrubs
      1) Buxus microphylla - Korean boxwood
      2) Euonymus kirutschovicus - spreading euonymus
      3) Ilex crenata 'helleri' - Japanese holly
      4) Juniperus chinensis 'hetzii' - hetzii juniper
      5) Juniperus chinensis 'phitzeriana' - phitzer juniper
      6) Mahonia aquifolium - Oregon grape holly
      7) Pinus mugo - mugo pine

8) Phododendron catawbiense - catawba rhododendron
9) Taxus cuspidata - Japanese yew
10) Thuja occidentalis - Eastern or American arborvitae or white cedar
11) Viburnum x rhytidophullodies - leatherleaf viburnum

F. Other activity

Have the students select a location for planting one or more shrubs on the school campus. Have them assess the campus to see if a hedge is needed to help direct traffic, or as a specimen, a windblock, or a screen (e.g. around trash dumpster). Then have them select a shrub to suit the location using the information found in the lesson. Have them plant their selection.

G. Conclusion

Shrubs serve as a transition from trees to the ground, help add depth and texture, define and enclose spaces, serve as specimen plants, and have many other purposes. Each shrub has its own unique characteristics that must be considered when selecting it for the landscape. Hedges serve to help direct traffic, provide a fence or screen, and they add a formal look to the landscape. Texture, size, form, and type (broad or narrow evergreen or deciduous) are major considerations in selecting shrubs.

H. Competency

Select effective shrubs and hedges for the landscape.

I. Answers to Evaluation

1. b
2. d
3. c
4. d
5. b
6. c
7. b
8. b

UNIT X - SELECTING AND USING PLANTS IN THE LANDSCAPE Name ________________

Lesson 2: Selecting Shrubs and Hedges for the Landscape Date ________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which statement best describes hedges?

   a) Hedges are several small hedge plants in a row.
   b) Hedges are shrubs that are usually massed together to form an unbroken line, and are trimmed to have a formal look.
   c) Shrubs are hedges that are usually massed together to form an unbroken line and are trimmed to have a formal look.
   d) Hedges are planted in a scattered arrangement throughout the lawn.

2. Which is not a purpose served by shrubs?

   a) To enclose spaces
   b) To help direct traffic
   c) To serve as a transition from trees to the ground
   d) To serve as a ceiling in the outdoor room

3. Which is a hedge that is used to help block wind, sun, and unsightly objects or views?

   a) Low hedge, one foot or less
   b) Medium hedge, up to six feet tall
   c) Tall hedge, over six feet tall
   d) Extra-tall hedge, over 15 feet tall

4. What is an important element to consider when selecting a shrub, since it is at eye level in the landscape?

   a) Form
   b) Hardiness
   c) Line
   d) Texture

5. Which of the following shrubs would be a good choice to use for a hedge to help direct traffic?

   a) Common lilac
   b) Japanese barberry
   c) Rosegold pussy willow
   d) Vanhoutte spirea

6. For which of the following shrubs would the winter stem color be an important characteristic to consider, when selecting a shrub to fit into a specific color scheme?

   a) Border forsythia
   b) Flowering quince
   c) Redosier dogwood
   d) Scarlet firethorn

7. Which broad-leaf evergreen should be grown in the following conditions; north or east exposure, soil high in organic matter, slightly acidic soil, partial shade, and protected from drying winds?

a) Japanese holly
b) Korean boxwood
c) Spreading euonymus
d) Winged euonymus

8. Which is one of the most frequently used evergreen shrubs; being very hardy, tolerant of poor soils, tolerant of sun or shade, upright or used as a hedge, free of serious pests or diseases, and easily pruned to keep its shape?

a) American arborvitae
b) Japanese yew
c) Mugo pine
d) Oregon grape holly

UNIT X - SELECTING AND USING PLANTS IN THE LANDSCAPE

Lesson 3: Selecting Ground Covers and Vines

Objective: The student will be able to select vines and ground covers for effective use in a landscape.

Study Questions

1. **What are the purposes of ground covers in the landscape?**
2. **What should be considered when selecting ground covers for the landscape?**
3. **What are the purposes of vines in the landscape?**
4. **What should be considered when selecting vines for the landscape?**
5. **What are the selection criteria for common ground covers and vines?**

Reference

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.

UNIT X - SELECTING AND USING PLANTS IN THE LANDSCAPE

Lesson 3: Selecting Ground Covers and Vines

TEACHING PROCEDURES

A. Review

Review previous lesson and review Unit III, Lesson 6.

B. Motivation

Ground covers and vines are the landscape plants that can be used in small areas or areas where other plants will not work. Learning their purposes and how to select them can help a landscaper liven up an area that would otherwise not be landscaped.

C. Assignment

D. Supervised study

E. Discussion

1. Ask the students what they would do for a client who wanted something planted in a very narrow area, on a steep slope with heavy shade, or dry soil that gets heavy, goot traffic. Suggest the use of ground covers.

   What are the purposes of ground covers in the landscape?

   a) Uses
      1) Steep slopes
      2) Sunny or shady areas
      3) Too wet or dry soil
      4) Too acidic or alkaline soil
      5) Hard-to-mow areas
         (a) Along highways
         (b) Around trees
      6) Control of erosion
      7) Narrow areas not suitable for turf
      8) Along paths, and around stepping stones in a garden
      9) Reduction of glare
      10) Prevention of rapid drying of soil
      11) Protection of shallow roots of trees and shrubs
      12) Help prevent weeds
   b) Aesthetic benefits
      1) Integration of shrub or tree planting
      2) Define ground planes
      3) Variety of colors, textures, and patterns
      4) Transition from turf to other plants or objects
      5) Creation of harmony and tranquility in landscape

2. Continue the discussion from question 1. If the student chooses a favorite ground cover; that requires full sun, moist soil, and cannot withstand foot traffic, without checking into its cultural requirements; the plant may suffer and die.

What should be considered when selecting ground covers for the landscape?

a) Determination of the status of existing site
    1) Shady or sunny
    2) Wet or dry soil
    3) Acidic or alkaline soil
    4) Hardiness zone - high and low temperatures
b) Determination of growth habit of ground cover
    1) Types of growth habit
        (a) Vining
        (b) Creeping - underground stolon
        (c) Prostrate
    2) Mature size
    3) Cultural requirements - light, water, and temperature
    4) Planting time
        (a) Avoiding winter heaving
        (b) Allowing time to get it established before winter

3. Ask the students what they would do, as landscapers, for a client who had a huge bare wall on the south side of the house and wanted to mask it, but had only a 12 inch strip of soil along the house in which to plant. Suggest vines.

What are the purposes of vines in the landscape?

a) Uses
    1) Provides more show for the least amount of ground space
    2) Screens
        (a) Privacy
        (b) Shade
    3) Beautifies fences or trellises
    4) Hides old tree stumps, utility poles, or dead trees
    5) Decorates rock walls
    6) As evergreen - year-round foliage
    7) As deciduous
        (a) Seasonal interest - winter stem pattern
        (b) Lets sun filter through in winter
c) Aesthetic benefits
    1) Softens fences, walls, and harsh architectural lines
    2) Creates a sense of ceiling and shelter
    3) Brings landscape down to human scale

4. Suppose the client described in the discussion before study question 3 had wet soil and wood siding on the house. Ask the students if these things would matter when they chose a vine to plant.

What should be considered when selecting vines for the landscape?

a) Existing soil and climate conditions
b) Method of climbing
    1) Twining
    2) Tendrils
    3) Clinging - not for use on wood
        (a) Suction cups
        (b) Aerial rootlets

c) Rate of growth
d) Mature size - height and width
e) Texture, density, and color
f) Seasonal features

5. Take the students to sites around town where vines and ground covers are used. Have them critique the uses as outlined in lessons 1 and 2. Also take them to sites where ground covers or vines are not used, but could be. Have them determine which vine or ground cover would be appropriate for the location by using the tables in the student reference. Have the students continue filling in the work sheets started in Unit III.

NOTE: All selection criteria are located in the tables in the student reference.

What are the selection criteria for common ground covers and vines?

a) Vines
    1) Celastrus scandens - American bittersweet
    2) Euonymus fortunei radicans - bigleaf wintercreeper
    NOTE: This is also a ground cover.
    3) Lonicera japonica 'Halliana' - Hall's honeysuckle
b) Ground Covers
    1) Ajuga reptans - ajuga or bugleweed
    2) Coronilla varis - crown vetch
    3) Hedra helix - English Ivy
    NOTE: This is also a vine.
    4) Juniperus horizontalis - creeping juniper
    5) Vincia minor - creeping myrtle or periwinkle

F. Other activity

Have the students assess the school campus to see if the use of ground covers or vines would be beneficial in any area. Have them select the proper ground cover or vine for the location. Have them plant the selection. (Obtain plants from local nursery/garden center or grow in greenhouse).

G. Conclusion

Ground covers and vines can be used in many hard-to-grow places. Their versatility is helpful in the landscape. Some ground covers can be used as vines with the proper support. Vines must be chosen carefully to provide the proper surface on which they may grow.

H. Competency

Know the uses of vines and ground covers and select the species to suit the location to be planted.

I. Answers to Evaluation

1. b
2. d
3. a
4. a
5. d
6. b
7. d

UNIT X - SELECTING AND USING PLANTS IN THE LANDSCAPE

Name ____________________

Lesson 3: Selecting Ground Covers and Vines

Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which is not a purpose served by ground covers in the landscape?

   a. Used as a matrix to integrate and accent shrubs and borders
   b. Used as a wall element in the outdoor room
   c. Used in areas too narrow or small for other plants
   d. Used in problem areas such as steep slopes, too wet or dry areas

2. Which of the following should not be considered when selecting ground covers?

   a. Growth habit
   b. Height
   c. Sunlight and water requirements
   d. Width

3. Which of the following is not a function of vines?

   a. Used as a matrix to integrate and accent shrubs and borders
   b. Used as a screen for privacy and shade
   c. Used to fill in a large area with use of little ground space
   d. Used to reduce heat and glare

4. What type of vines should not be used on wooden surfaces?

   a. Clinging
   b. Tendril climbing
   c. Twining
   d. Winding

5. Sue has an area in her backyard where she needs a ground cover and a vine. She wants to use the same plant for both purposes. There is a brick wall that will support the vine. The area is sunny in the morning and shady in the afternoon. Which of the following should she use?

   a. Bugleweed
   b. Creeping juniper
   c. Crown vetch
   d. English ivy

6. Tom has an area on a hillside that is in full sun and fairly dry where he wants to use a ground cover. He wants a fine-textured evergreen plant that has a bluish tint to it. Which of the following could be suggested?

   a. American bittersweet
   b. Creeping juniper
   c. Crown vetch
   d. Hall's honeysuckle

7. Bill has a steep hillside that cannot be mowed. This hill has poor soil and is eroding. It has a southern exposure. He wants a low-maintenance ground cover that blooms in summer. He wants this area to fill in quickly to prevent further erosion. Which of the following ground covers would be the best choice?

a. Big leaf wintercreep
b. Bugleweed or ajuga
c. Creeping juniper
d. Crown vetch

Lesson 4: Selecting Flowers

Objective: The student will be able to describe the purposes of flowers and how to select flowers for the landscape.

Study Questions

1. **What are the three groups of flowers?**
2. **What are the purposes of flowers in the landscape?**
3. **What should be considered when selecting flowers for the landscape?**
4. **What are the selection criteria for common perennials?**

Reference

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.

UNIT X - SELECTING AND USING PLANTS IN THE LANDSCAPE

Lesson 4: Selecting Flowers

TEACHING PROCEDURES

A. Review

B. Motivation

Flowers are the showiest element of the landscape. When the proper flowers are used in the proper context, a spectacular landscaping design can be made. Have some sample plants in pots on the desk or around the room for the students to see.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students what various types of flowers they have planted or watched others plant.

   What are the three groups of flowers?

   a) Annuals - bloom throughout season
      1) Hardy - can tolerate cool temperatures or frost
      2) Tender - cannot tolerate cool temperatures
   b) Perennials - one blooming period per season
      1) Hardy - can winter outdoors
      2) Tender - must be brought in for winter
   c) Biennials - 2 seasons: first year, vegetative; second year, flowering

2. Ask the students if they have been to an amusement park such as Six Flags or Worlds of Fun. Ask them if they noticed all of the many flower beds planted there. Ask them to imagine the park with out the flowers. Flowers can be displayed in many different ways and serve various purposes in landscape design.

   What are the purposes of flowers in the landscape?

   a) Bed
      1) Focal point of design
      2) Viewed from all sides
      3) Does not have backdrop
      4) Not to be used in public area
   b) Border
      1) Placed in front of backdrop - house, sidewalk, fence
      2) Viewed from only one side
      3) Softens the edges of buildings, sidewalks, fences, and lawns
   c) Other uses
      1) Containers
      2) Rock gardens
      3) Mass plantings
      4) Edgings

5) Ground covers
6) Hanging baskets
7) Rock walls
8) House plants
9) Specimens
10) Carpet and pattern beds
11) Cut flowers
12) Dried flowers

3. Perennials, as well as other flowers, are displayed in many different ways; including bed or border, hanging baskets, or containers. A perennial bed can be designed to have continuous color throughout the season. In order to do this, many factors must be considered such as when the plant blooms, and its height. Show the students slides or pictures of the same bed or border at different times in the summer. Point out that something is in bloom at all times and that this takes careful planning.

What should be considered when selecting flowers for the landscape?

a) Existing site conditions
b) Design decisions
  1) Bed or border
  2) Informal or formal
  3) Color scheme
c) Other characteristics
  1) Height
  2) Color
  3) Spread (width)
  4) Form
  5) Texture
  6) Blooming season
  7) Length of blooming time

4. Each perennial has its own characteristics that make it unique. These characteristics must be known before one can select a plant for a landscape design. For example; some are sun lovers, and some are shade lovers. Take the students on a field trip to see perennial beds or borders. Have the students continue filling out the work sheet started in Unit III.

NOTE: All selection criteria are located in the tables in the student reference.

What are the selection criteria for common perennials?

a) Artemisia schmidtiana - silver mound or silver king
b) Astilbe x ardendsii - false spirea
c) Aquilegia hybrids - columbine
d) Chrysanthemum hybrids - mum
e) Coreopsis lanceolata - coreopsis
f) Hemerocallis hybrids - day lily
g) Heuchera sanguinea - coral bells
h) Hosta species - plantin lily
i) Liriope spicata - lily turf
j) Phlox subulata - creeping phlox

F. Other activity

Have the students choose a proper location for a perennial bed or border. Have the students choose perennials that would best suit the location. Have them design the bed or border so that something is in bloom all season long. Have them plant the perennials.

G. Conclusion

With the variety of color, texture, and seasonal interest flowers allow, they should be used often, but selected with care. Knowledge of individual characteristics of flowers help a landscaper make successful selections for a landscape plan.

H. Competency

Select a location and plants for a perennial bed or border.

I. Answers to Evaluation

1. d
2. a
3. b
4. b
5. c

6. Answers may include: plant height, flower color, plant width, form, texture, length of blooming time, and blooming season.

7. 1 (astilbe), 3 (garden mum), 2 (columbine)
8. b, d, c, a

UNIT X - SELECTING AND USING PLANTS IN THE LANDSCAPE Name ____________

Lesson 4: Selecting Flowers Date ____________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which best describes perennials?

   a. Complete their life cycle in one growing season
   b. Complete their life cycle in two growing seasons
   c. Grow vegetatively the first year and flower the second year
   d. Live from year to year, dying in the winter and growing back the next year

2. What is characteristic of a group of flowers that the focal point of a design, is viewed from all sides, stands alone with no backdrop, and is not used in the public area of a yard?

   a. Bed
   b. Border
   c. Garden
   d. Mass planting

3. What are tubers, corms, rhizomes, and tuberous roots all examples of?

   a. Bulbous annuals
   b. Bulbous perennials
   c. Hardy annuals
   d. Tender annuals

4. What is characteristic of a group of flowers that is used in front of a backdrop of plants or a house, is viewed from only one side, and is no more than five feet deep?

   a. Bed
   b. Border
   c. Edge planting
   d. Garden

5. Which of the following perennials will grow best in full shade?

   a. Coral bells
   b. Lily turf
   c. Plantin lily
   d. Silver mound

Complete the following short answer questions.

6. What are six of the factors to be considered when selecting a perennial to be planted in a flower bed?

   a.

   b.

   c.

   d.

   e.

   f.

7. Place the following perennials in the proper order for flowering sequence, with the first blooming earliest in the spring the third blooming last in the fall.

   Astilbe
   Garden mum
   Columbine

8. Place the following list of perennials in order from shortest to tallest.

   a. Day lily
   b. Lily turf
   c. Plantin lily
   d. Silver mound

UNIT X - SELECTING AND USING PLANTS IN THE LANDSCAPE

Lesson 5: Selecting Turfgrasses

Objective: The student will be able to describe the purpose of turfgrass in landscaping and the criteria to consider when selecting a turfgrass.

Study Questions

1. **What are the purposes of lawns in the landscape?**
2. **What should be considered when selecting turfgrasses for the landscape?**
3. **What are the characteristics for the six major turfgrasses used in Missouri?**

Reference

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.

UNIT X - SELECTING AND USING PLANTS IN THE LANDSCAPE

Lesson 5: Selecting Turfgrasses

TEACHING PROCEDURES

A. Review

Review the previous lesson. Review Unit III, Lesson 7.

B. Motivation

In order to install and maintain a healthy turf, a landscaper must know how to select the grass that will be best suited for the area.

C. Assignment

D. Supervised study

E. Discussion

1. Ask the student to list all the ways they can think of that they have seen grass used.

What are the purposes of lawns in the landscape?

- a) Landscaping design
  - 1) Lowest growing plant material
  - 2) Finest texture
  - 3) Low, level foreground to build on
- b) Aesthetics
  - 1) Provide appealing, inviting, carpet around home
  - 2) Unify tree and flower plantings
  - 3) Provide play or work area
- c) Environment control
  - 1) Help control erosion
  - 2) Reduce sun's heat
  - 3) Reduce sun's glare

2. Ask the students to explain how they would choose a grass for their lawn.

What should be considered when selecting turfgrasses for the landscape?

- a) Microclimate factors
  - 1) Hardiness zone
  - 2) Average temperatures
  - 3) Moisture conditions
  - 4) Sunny or shady areas
  - 5) Slopes, if any
  - 6) Soil condition
    - (a) Texture
    - (b) pH
- b) Species characteristics
  - 1) Temperature requirements

- (a) Cool-season
- (b) Warm-season

2) Moisture tolerance
   - (a) Drought-tolerant
   - (b) Needs moisture
3) Annual or perennial
4) Light requirements
   - (a) Sun
   - (b) Shade
   - (c) Part sun, part shade
5) Durability
   - (a) Light traffic
   - (b) Heavy traffic
6) Habit of growth
   - (a) Creeping
   - (b) Bunching
7) Planting method
   - (a) Seeding
   - (b) Sprigging or plugging
8) Planting time
   - (a) Spring
   - (b) Fall
9) Planting rate
   - (a) Pounds of seed per square foot
   - (b) Sprigs per square foot
10) Rate of growth
11) Fertilization requirements
    - (a) Heavy
    - (b) Medium
    - (c) Low
12) Time of fertilization
    - (a) Spring
    - (b) Summer
    - (c) Fall
    - (d) Winter
13) Pests and diseases
    - (a) Resistance
    - (b) Susceptibility
14) Mowing height
15) Natural height
16) Used as a single species or a mixture

3. Take the students on a field trip to see as many of the types of grasses as possible. Notice the locations they are growing in and the purposes they serve. (football field, meadow, lawn, high traffic area, etc.) Notice their habit of growth (creeping or bunching).

NOTE: All selection criteria are located in the table in the student reference.

What are the characteristics for the six major turfgrasses used in Missouri?

a. Cynodon dactylon - Bermudagrass
b. Festuca arundinacea - Tall fescue
c. Festuca rubra - Red fescue
d. Lodium perenne - Perennial ryegrass

   e. Poa pratensis - Kentucky bluegrass
   f. Zoysia japonica - Zoysia grass

F. Other activity

Have the students select a location on the school grounds that needs to have grass planted. Have them select the grass that would serve the purpose needed and that will grow in the location. Have them sow seed or plant sprigs.

G. Conclusion

Turfgrasses are used to create appealing lawns that serve to unify tree and flower plantings around a home. Turfgrasses are also used for parks, commercial sites, and athletic fields. The existing conditions on a site, as well as characteristics of an individual turfgrass, must be known in order to select a successful turfgrass for a growing site.

H. Competency

Select a turfgrass for a specific growing site.

I. Answers to Evaluation

1. c
2. b
3. d
4. a
5. b
6. b

7. Answers may include the following: provide a carpet of green, unify trees and flower plantings, control erosion, reduce glare, reduce heat, provide play or work area.

Name ____________________

Lesson 5: Selecting Turfgrasses

Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which is not an important consideration when assessing a prospective site for planting turfgrass?

   a. The amount of sunlight it receives
   b. The average temperature
   c. The planting time
   d. The soil texture and pH

2. Kenny planted Bermudagrass under a grove of oak trees. His grass died. What did Kenny fail to check concerning the grass?

   a. Disease problems
   b. Light requirements
   c. Moisture requirements
   d. Seeding rate

3. Joe needs a warm-season, perennial grass that will spread to fill a large area and can be planted in late April. His lawn receives sun, but is partially shaded. What should he use?

   a. Kentucky bluegrass
   b. Perennial ryegrass
   c. Tall fescue
   d. Zoysia grass

4. Which of the following turfgrasses has a blue-green color?

   a. Bermudagrass
   b. Perennial ryegrass
   c. Red fescue
   d. Zoysia grass

5. Which is cool-season grass that has a rapid establishment time and is a creeping type of grass?

   a. Bermudagrass
   b. Kentucky blue grass
   c. Red fescue
   d. Zoysia grass

6. Which is a shade-tolerant grass that will not tolerate high heat and requires very little fertilizer?

   a. Bermuda grass
   b. Red fescue
   c. Tall fescue
   d. Zoysia grass

Complete the following short answer question.

7. What are five purposes of turfgrasses?

   a.
   b.
   c.
   d.
   e.

UNIT XI - LANDSCAPE DESIGNING

Lesson 1: Design Elements

Objective: The student will be able to identify and explain the four elements of landscape design.

Study Questions

1. **How can various textures be used in the landscape?**
2. **What are the basic plant forms?**
3. **What environmental factors affect the impact of color in the landscape?**
4. **How does line contribute to the landscape?**
5. **How can the landscape design stimulate emotion?**

Reference

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia, Instructional Materials Laboratory, 1990.

UNIT XI - LANDSCAPE DESIGNING

Lesson 1: Design Elements

TEACHING PROCEDURES

A. Introduction

Landscape design is not just choosing any plant to fit into a landscape. It is choosing the correct plant to fit a landscape plan, according to the plant's physical features.

B. Motivation

Landscape designers need to understand the design elements in order to create a unified landscape plan. An appealing landscape design will be saleable to the client.

C. Assignment

D. Supervised study

E. Discussion

1. Show class three plants with various textures and ask the students to compare and contrast the textures of these plants.

   How can various textures be used in the landscape?

   a) Texture is relative to what is being compared.
   b) Texture creates an illusion of depth.
      1) Fine textures recede.
      2) Coarse textures advance.

2. Provide students with three plants with different forms and ask them to compare and contrast the forms.

   What are the basic plant forms?

   a) Vertical or upright
   b) Horizontal or spreading
   c) Pendulous
   d) Trailing
   e) Mounding
   f) Irregular
   g) Pyramidal
   h) Columnar
   i) Rounded
   j) Oval
   k) Vase-shaped

3. Ask students to name the primary colors. Ask students to compare and contrast the colors of three plants with different colors of green foliage.

What environmental factors affect the impact of color in the landscape?

a) Season
b) Weather conditions
c) Time of day
d) Distance
e) Light intensity
f) Background against which the color is placed

4. Provide students with three different plants and ask them to discuss the line of each.

How does line contribute to the landscape?

a) Line defines form.
b) Line gives direction.

5. Show students three different plants and ask them to discuss which plant they like best and why.

How can the landscape design help to stimulate emotion?

a) Choice of size
b) Choice of line
c) Choice of color - warm and cool

F. Other activities

1. Have students make a texture chart, line chart, form chart, or color chart.

2. Take students on a field trip to a landscaped home and discuss the four elements of design in this particular landscape.

G. Conclusion

Line, form, color, and texture are the four elements of landscape design. These elements help to enhance a landscape design.

H. Competency

Identify and explain the four elements of landscape design.

I. Answers to Evaluation

1. d
2. a
3. a
4. c
5. b
6. d
7. b
8. c
9. a. Irregular
   b. Pyramidal
   c. Columnar

UNIT XI - LANDSCAPE DESIGNING

Name ____________________

Lesson 1: Design Elements

Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which is not a physical feature of a plant in relation to texture?

   a. Bark
   b. Branches
   c. Foliage
   d. Roots

2. What is simple leaf texture?

   a. Coarse
   b. Fine
   c. Medium
   d. Receding

3. Where is the best place for coarse plants in the landscape?

   a. In the foreground
   b. In the background
   c. Under trees
   d. Directly next to fine texture plants

4. How many dimensions does a plant form have?

   a. One
   b. Two
   c. Three
   d. Four

5. Which of the following will plants in their native habitat tend to grow as?

   a. Pyramidal
   b. Irregular
   c. The weather
   d. The terrain

6. Which of the following give the longest lasting color in the environment?

   a. Bark
   b. Buds
   c. Flowers
   d. Foliage

7. Which is not an environmental factor affecting color?

a. Background
b. Client's choice of color
c. Season
d. Time of day

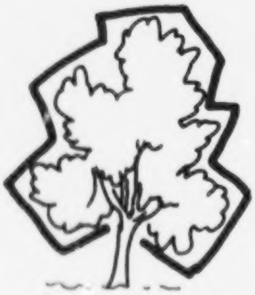
8. What feeling does tone in color help create?

a. Craziness
b. Happiness
c. Peacefulness
d. Sadness

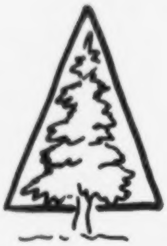
Complete the following short answer question.

9. What are the following forms of plants?

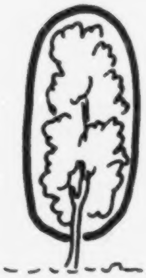
a. ______________________________



b. ______________________________



c. ______________________________



UNIT XI - LANDSCAPE DESIGNING

Lesson 2: Landscape Enrichments

Objective: The student will be able to implement the use of natural and manufactured materials in a landscape plan.

Study Questions

1. **What are the purposes of landscape enrichments?**
2. **What are some natural enrichments?**
3. **What should be considered when selecting natural enrichments for the landscape?**
4. **What are some types of manufactured enrichments?**
5. **What outdoor surfacing materials are used in the landscape?**

References

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
2. Work Sheet
    a) WS 2.1: Landscape Enrichments

UNIT XI - LANDSCAPE DESIGNING

Lesson 2: Landscape Enrichments

TEACHING PROCEDURES

A. Review

Review the previous lesson.

B. Motivation

Landscaped areas can be enhanced with beautiful and properly placed plants. A landscaped area's attractiveness, as well as its monetary value, can be increased further by using natural and manufactured enrichments.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students what the word "enrichment" means. Break the word down into its root word if they have difficulty with the meaning.

   What are the purposes of landscape enrichments?

   a) Natural enrichments
      1) Enhance the landscape
      2) Create beauty and serenity in the landscape
   b) Manufactured enrichments
      1) Add unity and harmony to the landscape plan

2. Ask students to recall a pleasant experience in nature and what elements added to their enjoyment of that place.

   What are some natural enrichments?

   a) Tangible
      1) Stones, rocks, boulders
      2) Plants
      3) Water
      4) Animals
   b) Intangible
      1) Sounds of nature; birds, wind, running water
      2) Scents of flowers and blossoms on shrubs and trees
      3) Taste of fruit and vegetables from garden areas

3. Ask students what they consider when selecting clothes; including the look, fit, and color coordination.

What should be considered when selecting natural enrichments for the landscape?

- a) Theme of landscape design
- b) Smell/allergies
- c) Attraction of unwanted animals

4. Ask students what manufactured means. Ask them to list manufactured items.

What are some manufactured enrichments?

- a) Outdoor furniture
- b) Outdoor art
- c) Pools and fountains
- d) Night lighting
  - 1) Silhouette lighting
  - 2) Shadow lighting
  - 3) Up lighting
  - 4) Down lighting

5. Discuss with students the materials needed to build a house.

What outdoor surfacing materials can be used in the landscape?

- a) Turf
- b) Ground covers
- c) Flowers
- d) Paving
  - 1) Hard
  - 2) Soft

F. Other activity

Take a field trip to see different types of construction materials and surfacing materials.

G. Conclusion

The landscape can be enhanced not only by proper placement of plants, but also with the addition of natural and manufactured enrichments. Natural enrichments are any objects of nature that can enhance the landscape. Construction and surfacing materials are manufactured enrichments that can be added to the landscape.

H. Competency

Implement the use of natural and manufactured enrichments in a landscape plan.

I. Answers to Evaluation

1. d
2. c
3. d
4. c
5. b
6. Answers may include: rocks, stones, decayed wood, boulders, plants, water, and animals.

7. Answers may include: sounds of animals; taste of fruit or vegetables; fragrance of flowers, trees, shrubs; songs of birds; sound of running water; wind in trees.

J. Answers to Work Sheet

Up to teacher's discretion

UNIT XI - LANDSCAPE DESIGNING Name ____________________

Lesson 2: Landscape Enrichments Date ____________________

EVALUATION

Circle the letter that best corresponds to the best answer.

1. What are the purposes of manufactured enrichments?

    a. Focal points and distinction
    b. Grace and elegance
    c. Line and distinction
    d. Unity and harmony

2. A bird bath is what type of manufactured enrichment?

    a. Night lighting
    b. Outdoor furniture
    c. Outdoor sculpture
    d. Pools and fountains

3. Which of the following is a disadvantage of pools and fountains?

    a. Being installed above ground
    b. Being installed below ground
    c. Enhances only plaza areas
    d. High maintenance

4. Lighting that is placed behind plants outlining the plants is which type of night lighting?

    a. Down
    b. Shadow
    c. Silhouette
    d. Up

5. Which of the following is a soft paving material?

    a. Concrete
    b. Gravel
    c. Stone
    d. Tile

Complete the following short answer questions.

6. What are three tangible, natural enrichments?

    a.

    b.

    c.

7. What are three intangible, natural enrichments?

a.

b.

c.

UNIT XI - LANDSCAPE DESIGNING WS 2.1

Lesson 2: Landscape Enrichments

Work Sheet 2.1: Landscape Enrichments

Walk the school campus, or another assigned site, and list the different types of enrichments that are found.

MANUFACTURED ENRICHMENTS

Outdoor Furniture
1.
2.
3.

Outdoor Art
1.
2.
3.

Pools and Fountains
1.
2.
3.

Night Lighting
1.
2.
3.

NATURAL ENRICHMENTS

Tangible
1.
2.
3.
4.

Intangible
1.
2.
3.
4.

Surfacing Materials

Paving

Hard
1.
2.
3.

Soft
1.
2.
3.

Turf
1.
2.
3.

Ground Covers
1.
2.
3.

Flowers
1.
2.
3.

UNIT XI - LANDSCAPE DESIGNING

Lesson 3: Principles of Design

Objective: The student will be able to identify the five principles of design.

Study Questions

1. **Why is it important to consider mature sizes of plants when planning the landscape?**
2. **What are the two types of balance and how do they differ?**
3. **What is rhythm in relation to landscape design?**
4. **How is simplicity achieved in a landscape design?**
5. **How can a focal point be established?**

References

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
2. Work Sheet
   - a) WS 3.1: Balance

Lesson 3: Principles of Design

TEACHING PROCEDURES

A. Review

Review the previous lesson.

B. Motivation

A landscape design that uses design principles along with the elements of design will be appealing.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students to discuss how humans and animals physically change from infants to adults. Apply this principle to plants.

   Why is it important to consider the mature sizes of plants when planning the landscape?

   Landscape plans are designed with mature plant sizes in mind so that the plants will not grow too large to keep the plan in balance, and become out-of-proportion to other items in the design.

2. Divide the room in half and move students from one side to the other to demonstrate balance.

   What are the two types of balance and how do they differ?

   a) Symmetrical balance - One side is equal to the other side.
   b) Asymmetrical balance - One side looks like it has more than the other side, but is equal in balance.

3. Have students listen to different kinds of music (country, rock, classical) to hear the repetition in the music.

   What is rhythm in relation to landscape design?

   Rhythm is the sequence or repetition of the design elements and gives a sense of movement.

4. Show students different pictures (can be from magazines or books) of houses that appear cluttered with plants. Ask students what is wrong with the pictures.

   How is simplicity achieved in a landscape design?

   a) Make straight lines into curves.
   b) Avoid complicated forms that conflict with building shapes or area shapes.
   c) Use group plantings.
   d) Do not emphasize just one design element.

5. Ask students what they think the main attractions are in the classroom, in a living room, and in a kitchen.

How can a focal point be established?

Focal point is established using a combination of the design elements to create a point of immediate, visual attraction.

F. Other activity

Have students use construction paper to cut out pieces of paper to paste onto other pieces of paper in order to create the following:

a) Balance - symmetrical and asymmetrical
b) Rhythm
c) Focal points

G. Conclusion

A creative and harmonious landscape design is achieved by using the principles of design. These design principles are proportion, balance, rhythm, simplicity, and focal point.

H. Competency

Identify the five principles of design.

I. Answers to Evaluation

1) d
2) b
3) d
4) a
5) c
6) b

J. Answers to Work Sheet

Up to teacher's discretion

UNIT XI - LANDSCAPE DESIGNING

Lesson 3: Principles of Design

Name ____________________

Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which is not a principle of design?
   - a. Focal point
   - b. Proportion
   - c. Rhythm
   - d. Texture

2. What is the overall size of a landscape plan?
   - a. Focal point
   - b. Proportion
   - c. Scale
   - d. Simplicity

3. What is a mirror image balance called?
   - a. Asymmetrical
   - b. Linear
   - c. Off-balance
   - d. Symmetrical

4. What is the type of balance most frequently found in nature?
   - a. Asymmetrical
   - b. Linear
   - c. Off-balance
   - d. Symmetrical

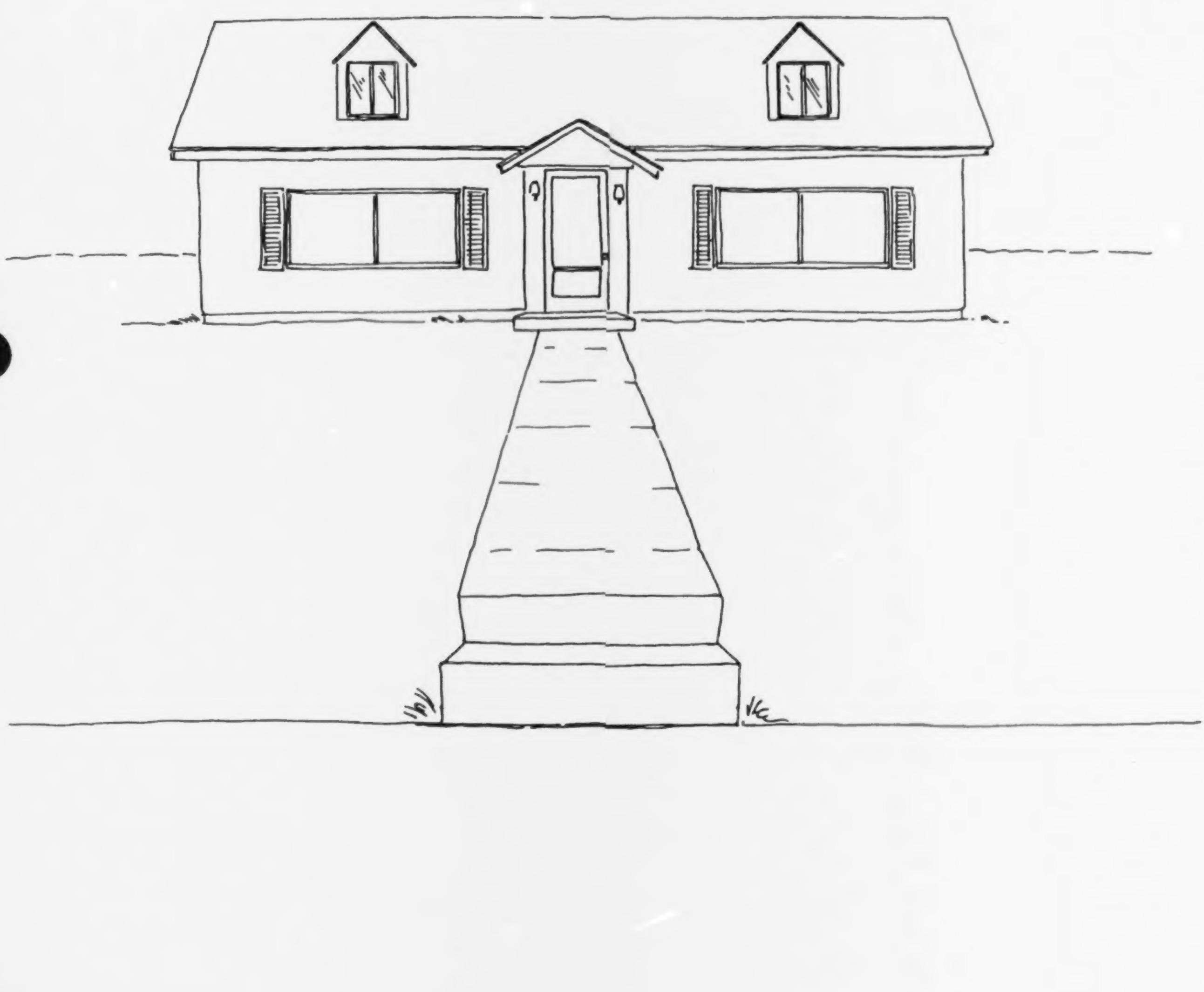
5. What does too much repetition in rhythm causes?
   - a. Chaos
   - b. Harmony
   - c. Monotony
   - d. Simplicity

6. What is the use area with only one focal point?
   - a. Private use area
   - b. Public use area
   - c. Service/utility use area
   - d. None of the above

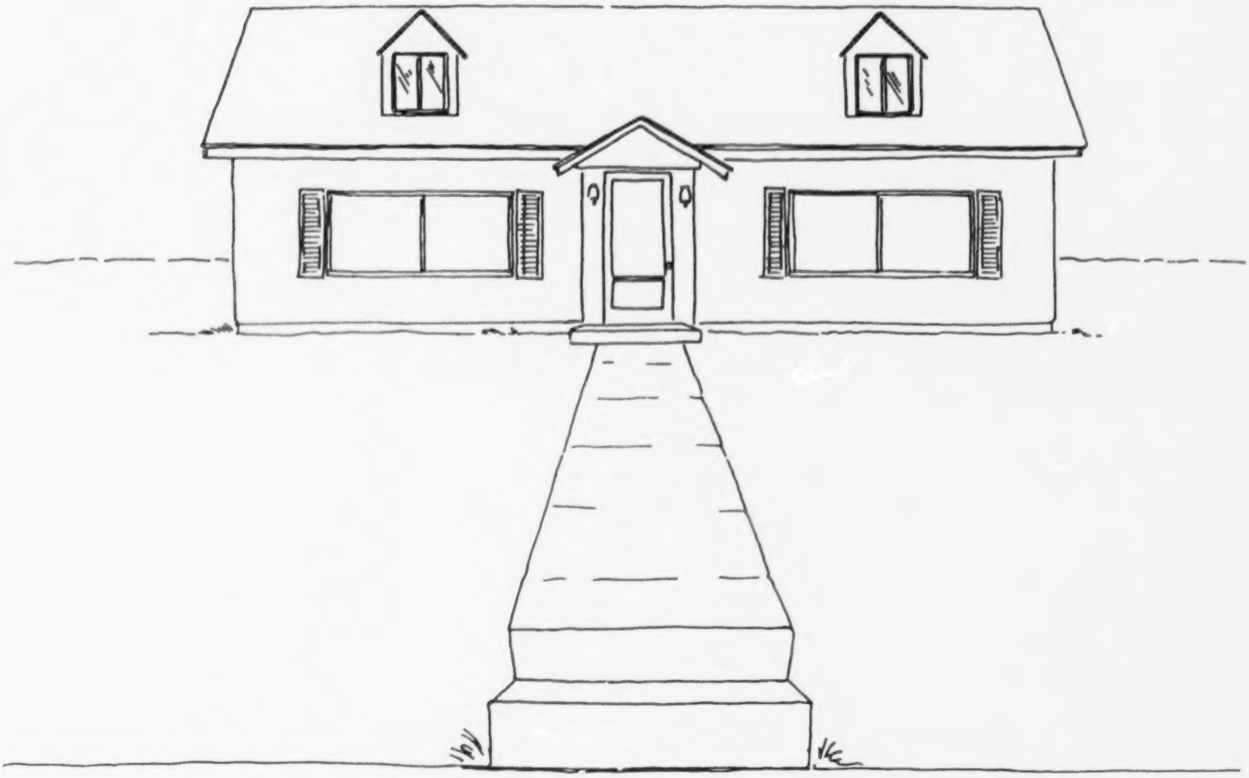
Lesson 3: Principles of Design

Work Sheet 3.1: Balance

1. Sketch a landscape with symmetrical balance.



2. Sketch a landscape with asymmetrical balance.



UNIT XI - LANDSCAPE DESIGNING

Lesson 4: Applying Design Elements and Principles

Objective: The student will be able to combine design elements and principles to create a landscape plan.

Study Questions

1. **How can plants in an area support the focal point?**
2. **What are the three basic ways of arranging trees and shrubs?**
3. **How can an entrance in a public area be designed?**
4. **How can private and service/utility areas be designed?**

References

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
2. Work Sheets

   a) WS 4.1: Designing a Corner Planting
   b) WS 4.2: Designing a Line Planting
   c) WS 4.3: Designing the Public Area
   d) WS 4.4: Designing the Public Area
   e) WS 4.5: Designing the Private/Service Area

Lesson 4: Applying Design Elements and Principles

TEACHING PROCEDURES

A. Review

Review Lessons 1, 2, and 3.

B. Motivation

Design elements and principles, when used effectively in a landscape design, will help sell the design to the client.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students what the different ways are that a school might support its football, basketball, or baseball teams.

   How can plants in an area support the focal point?

   a) Specimen plants
   b) Accent plants
   c) Mass plantings

2. Ask students to discuss the different ways that a classroom can be arranged.

   What are the three basic ways of arranging trees and shrubs?

   a) Line plantings
   b) Corner plantings
   c) Foundation plantings

3. Ask students what the function of a public area is.

   How can an entrance in a public area be designed?

   a) Funneling approach
   b) Use of enrichments
   c) Use of corner, line, or foundation plantings

4. Ask students what the function of the private and service/utilities are.

   How can private and service/utility areas be designed?

   a) Private area
      1) Emphasize focal point.
      2) Complement focal point.

        3) Design according to size, shape, and use.
        4) Design formally or informally, according to client's desire.
    b) Service/utility area
        1) Design with or without focal point.
        2) Screen partially or totally.
            (a) Use line or corner plantings.
            (b) Use construction materials.

F. Other activity

Take students on field trip to see corner, line, and foundation plantings.

G. Conclusion

Each area in a landscape plan is designed separately while blended together harmoniously by applying the design elements and principles. Each area is landscaped with line, corner, or foundation plantings. Accent, mass, and specimen plants can be used in these plantings.

H. Competency

Apply both the principles and elements of design to create a landscape plan.

I. Answers to Evaluation

1. a
2. b
3. d
4. b
5. b
6. c
7. a
8. d

J. Answers to Work Sheets

At teacher's discretion

UNIT XI - LANDSCAPE DESIGNING Name ____________________

Lesson 4: Applying Design Elements and Principles Date ____________________

EVALUATION

Circle the letter that corresponds to the correct answer.

1. What type of plant has a strong, visual feature but is most effective when planted in groupings?

    a. Accent plant
    b. Group plant
    c. Mass plant
    d. Specimen plant

2. What kind of plant is a yew?

    a. Accent plant
    b. Mass plant
    c. Single plant
    d. Specimen plant

3. Why is a line planting used?

    a. To block a view
    b. To provide total privacy
    c. To give no privacy
    d. All the above

4. What is the in-curve of a corner planting?

    a. Where the shortest plant is placed
    b. Where the tallest plant is placed
    c. Not part of the corner planting
    d. The furthest point from the center of the corner planting

5. Which is not true of foundation planting?

    a. It was used many years ago.
    b. It is not necessary today.
    c. It unites the house to the yard.
    d. It is not necessary to cover entire foundation area of the house.

6. Line, corner, and foundation plantings are most effective when plants are placed in groups of how many?

    a. Four
    b. Six
    c. Seven
    d. Eight

7. How can the front doorway of the public area be enhanced?

   a. By using the funnel approach
   b. By covering the doorway with plantings
   c. By placing three specimen plants together at the doorway
   d. By leading people to the private area

8. Which is not true about the private area?

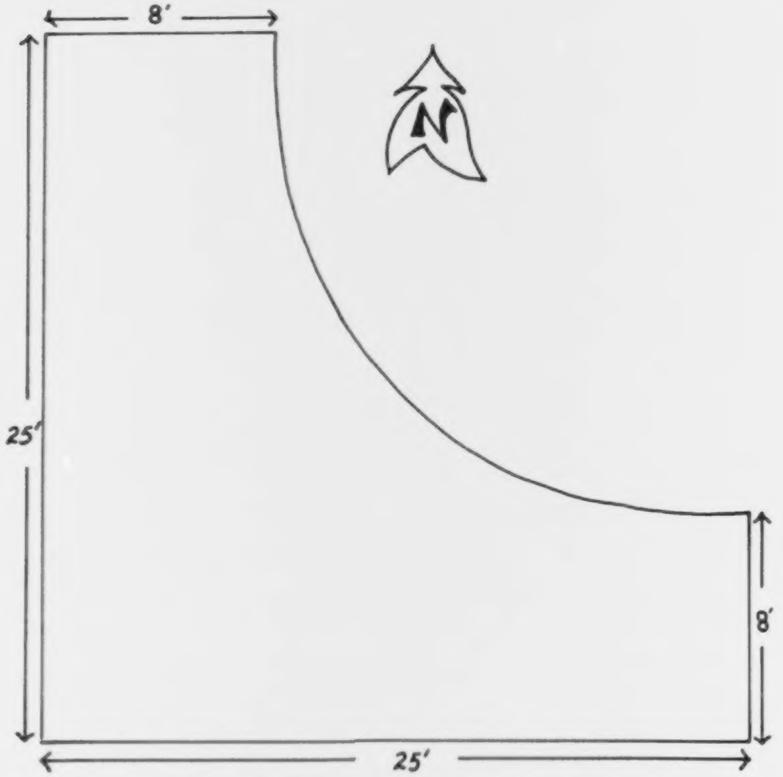
   a. It is a place of relaxation.
   b. It is the continuation of the house to the outdoors.
   c. It requires an open space for activities.
   d. It should only be informally landscaped.

Lesson 4: Applying Design Elements and Principles

Work Sheet 4.1: Designing a Corner Planting

Using the measurements given, complete the following steps in designing a corner planting.

1. Draw the corner planting to scale, using a 1" = 4' scale, on graph paper.
2. Design with the idea that the client's view will be directed at the in-curve.
3. Make a plant list of all plant materials used.
4. Make a title block.

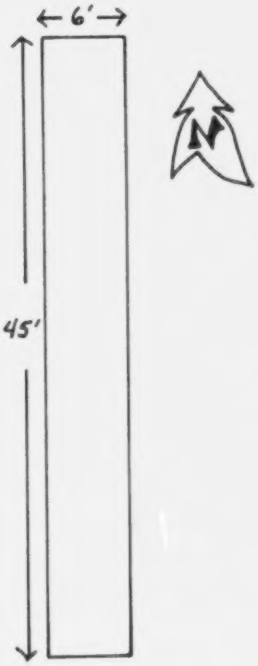


Lesson 4: Applying Design Elements and Principles

Work Sheet 4.2: Designing a Line Planting

Using the measurements given, complete the following steps in designing a line planting.

1. Draw a line planting to scale, using a 1" = 4', on graph paper.
2. Design with the idea that the client's view will be from the southeast. The line planting will be used as a partial screen. Keep in mind using only a few species of plants to maintain simplicity, and use mass groupings.
3. Make a plant list of all plant materials used.
4. Make a title block.

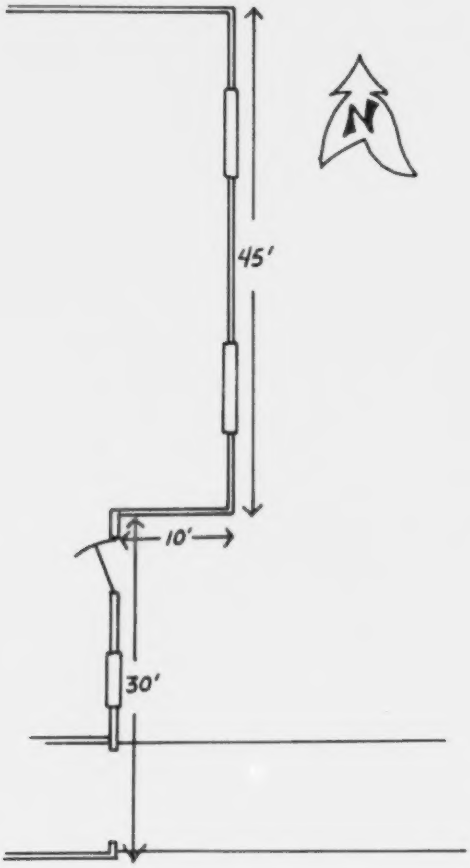


Lesson 4: Applying Design Elements and Principles

Work Sheet 4.3: Designing the Public Area

Using the measurements given, complete the following steps in designing the public area.

1. Draw this section of house on graph paper using a scale of 1" = 4'.
2. Design the public area using the front door as the focal point. Use corner and foundation plantings with mass groupings, accent, or specimen plants.
3. Make a list of all plant materials used. Design with plants that will grow well in this sunlight. Remember not to cover the windows with plants.
4. Make a title block for this design.



Lesson 4: Applying Design Elements and Principles

Work Sheet 4.4: Designing the Public Area

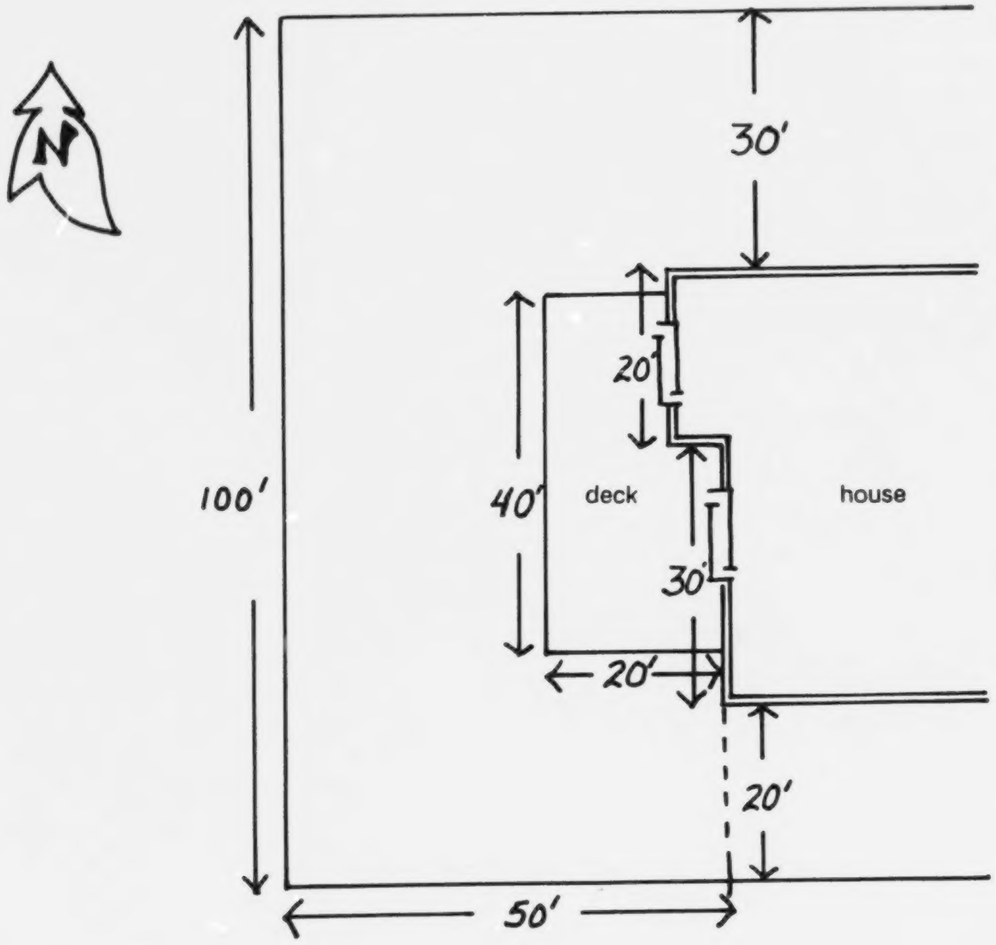
1. Design the public area of a house from the front view using background, corner plantings, and foundation plantings.

Lesson 4: Applying Design Elements and Principles

Work Sheet 4.5: Designing the Private and Service Areas

Using the measurements given, complete the following steps in designing the private and service areas.

1. Draw the private and service areas to scale using a 1" = .4'.
2. Design the area with line and corner plantings. Create a focal point in the Southwest corner to shade the patio from afternoon sun. Design a partial screen for privacy from the western neighbor. Add color to the design.
3. Make a list of all plant materials used.
4. Make a title block.



UNIT XI - LANDSCAPE DESIGNING

Lesson 5: Developing a Landscape Plan

Objective: The student will be able to develop a complete landscape plan.

Study Questions

1. **What are the basic steps in developing a landscape plan?**
2. **What planning should be done before beginning the actual drawing?**
3. **How is the plan implemented according to the seasons?**
4. **What characteristics make a plan more saleable?**

References

1. Landscaping and Turf Management. (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
2. Work Sheets
    - a) WS 5.1: Developing a Landscape Plan
    - b) WS 5.2: Developing a Landscape Plan

UNIT XI - LANDSCAPE DESIGNING

Lesson 5: Developing a Landscape Plan

TEACHING PROCEDURES

A. Review

Review Units 9-11.

B. Motivation

Before a client will buy a landscape design and have it installed, the design must be saleable. If a landscape designer follows the basic steps in developing a plan, the design will have the characteristics necessary to make it saleable.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students to figure a math problem such as 2 x 3 + 1 = 7. Explain that just as a math problem has steps that must be followed to find the correct answer, there are steps to developing a landscape plan. Have students complete WS 5.1 and 5.2.

   What are the basic steps in developing a landscape plan?

   a) Analysis of home needs
   b) Site analysis
   c) Design concept
   d) Design solution stage

2. Ask students to explain what planning must be done before the FFA can put on their annual banquet. Just as we plan for activities, such as the annual banquet, we also have to plan before we start to design a landscape.

   What planning should be done before beginning the actual drawing?

   a) Analysis of home needs
   b) Site analysis
   c) Base map

3. Ask students what seasons of the year are popular for poinsettias, Easter lilies, chrysanthemums, and tulips.

   How can the plan be implemented according to the seasons?

   a) Turf
      1) Warm-season, late spring or early summer
      2) Cool-season, early spring or early fall
   b) Bulbs, spring and fall
   c) Vegetable garden

        1) Cool-season crops, early spring and early fall
        2) Warm-season crops, late spring and early summer
    d) Trees, dependent on individual specie
    e) Shrubs, dependent on individual specie

4. Ask students how an employer might select among many applications to fill an opening in his business.

   What characteristics make a plan more saleable?

   a) Designer
      1) Friendliness and courteousness
      2) Good verbal communication skills
      3) Flexibility to change
   b) Design
      1) Accuracy
      2) Neatness
      3) Legibility
      4) Communication of designer's ideas and concepts
      5) Creativity
      6) Adaptibility to client's needs
      7) Adaptibility to client's budget

F. Other activity

Students will complete a landscape plan by using the four basic steps for developing one.

G. Conclusion

Developing a landscape plan is a problem-solving activity that consists of four basic steps. A designer must use analysis of home needs, site analysis, development of the design concept and the design solution. The designer should have knowledge of seasonal considerations in implementing the plan. Both designer and design should have characteristics which enhance the saleability of the plan.

H. Competency

Develop a complete landscape plan.

I. Answers to Evaluation

1. c
2. d
3. b
4. a
5. d

6. The answer should include four of the following: accuracy, neatness, legibility, effective communication of designer's ideas, creativity, adapts to client's needs, or adapts to client's budget.

J. Answers to Work Sheets

WS 5.1 - at teacher's discretion

WS 5.2 - at teacher's discretion

Name ____________________

Lesson 5: Developing a Landscape Plan

Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which is the first step in developing a landscape plan?

   a. Design concept
   b. Design solution stage
   c. Home needs analysis
   d. Site analysis

2. Which of the following is not a part of the planning needed to design a landscape?

   a. Drawing a base map
   b. Installation of design
   c. Home needs analysis
   d. Site analysis

3. When should turf be planted?

   a. Fall or winter
   b. Spring or fall
   c. Summer or fall
   d. Summer or spring

4. When are cool-season vegetable crops planted?

   a. Early spring and early fall
   b. Late spring and early summer
   c. Spring and late summer
   d. Summer and early fall

5. Which is not a characteristic of an effective landscape designer?

   a. Flexibility to change
   b. Friendliness and courteousness
   c. Good communication skills
   d. Trys to change the client's mind

Complete the following short answer question.

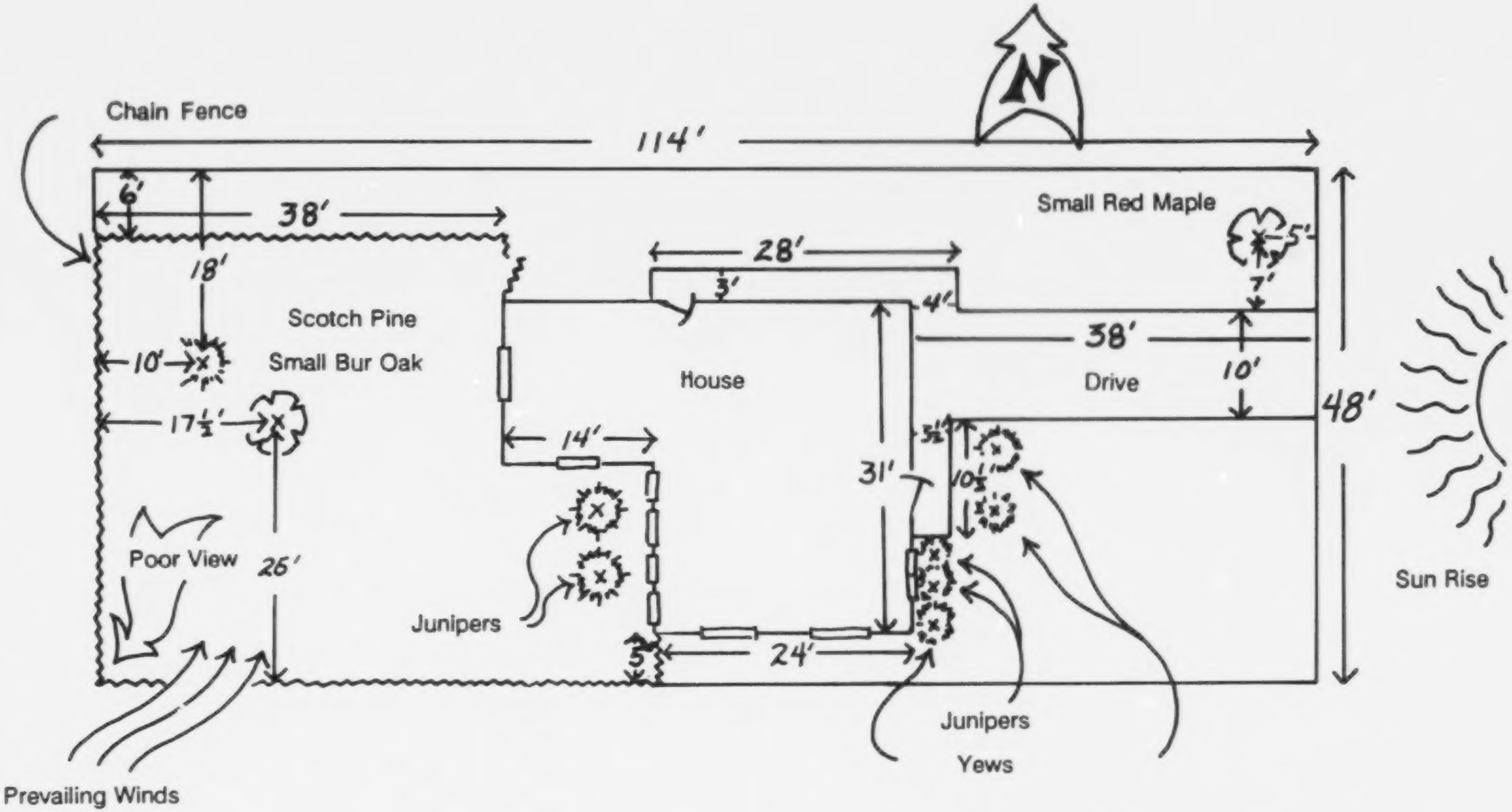
6. What are four characteristics of a saleable landscape plan?

   a.
   b.
   c.
   d.

Lesson 5: Developing a Landscape Plan

Work Sheet 5.1: Developing a Landscape Plan

With the analysis of family needs and the site analysis provided, design a complete landscape plan for the existing home site below.


N
Chain Fence
114'
6'
38'
18'
Scotch Pine
10'
Small Bur Oak
17½'
28'
3'
4'
Small Red Maple
5'
7'
38'
10'
Drive
48'
House
14'
31'
3½'
10½'
Poor View
26'
Junipers
5'
24'
Junipers
Yews
Sun Rise
Prevailing Winds

ANALYSIS OF FAMILY NEEDS

Location 000 Pinewood Ave. Lot No. ____ Date ____________

Client Name Mr. & Mrs. Sam Somebody Telephone No. 555-6983

Number of Children - Pre-school ______ Elementary 3 High School ________

Activities **Needs**

Entertaining:

Paved area - capacity (people) ______ size _______

color __________ material ____________________ plotted _____

Shade - canopy _______ trellis ________

umbrella ________ tree ✓ ____________________ plotted _____

Seating - benches _______ capacity _______

no. _______ style ________________ plotted _____

chairs ____ no. ______ style ____________ plotted _____

chairs - folding _____ no. _____ style _____

storage _____________

tables _______ no. ________ style _________ plotted _____

table - dining ____ capacity ____ style _____

plotted _____

Garden lighting ___ kind ____ style _____ no. _____ plotted _____

____ _____ _____ _____

____ _____ _____ _____

Cooking:

Grill - permanent ____ size ____ style ____________ plotted _____

portable ___ size ____ style ______ storage plotted _____

Table - work ___ dimensions _____ style ____________ plotted _____

Storage for cooking _____ dimensions ______________ plotted _____

Electrical outlets ________ no. ___________________ plotted _____

Games:

Croquet _____ dimensions 30' x 60' plotted _____

Badminton _____ dimensions 24' x 54' plotted _____

Bowling on the green _____ dimensions 10' x 50' or 20' x 100' plotted _____

Volleyball _____ dimensions 40' x 70' plotted _____

Basketball hoop _____ dimensions 40' x 40' plotted _____

Tetherball _____ dimensions 20' dia. circle plotted _____

Horseshoes _____ dimensions 20' x 40' plotted _____

Archery _____ dimensions 20' x 100' min. plotted _____

Putting green _____ dimensions 30' dia. circle min. plotted _____

Shuffleboard _____ dimensions 6' x 45' plotted _____

Other __________ dimensions ____________________ plotted _____

Game storage _____ length _____ width _____ height _____

plotted _____

Playing:

Sandbox _____ dimensions ______________________ plotted _____

Swings _____ dimensions ______________________ plotted _____

Slide _____ dimensions ______________________ plotted _____

Playhouse _____ dimensions ______________________ plotted _____

Monkeybars _____ dimensions ______________________ plotted _____

Wading pool _____ dimensions ______________________ plotted _____

Blackboard _____ dimensions ______________________ plotted _____

Other (specify) ____________ dimensions ____________ plotted _____

Storage, wheel toys, etc. _____ dimensions ________ plotted _____

Activities **Needs**

Swimming:
Pool ____ dimensions ____ shape ____
material ____ plotted ____
Diving board ____ dimensions ____ plotted ____
Paved area ____ dimensions ____
material ____ plotted ____
Enclosure ____ plotted ____
Equipment storage ____ plotted ____

Gardening:
Minimum maintenance ✓
Automatic watering system ____ plotted ____
Flower beds ✓ annuals ✓ perennials ✓
roses ✓ mixed ____ plotted ____
Planter boxes ____ kind ____ plotted ____
Water garden ____ water lilies ____ fountain ____
dimensions ____ plotted ____
Cutting garden ____ dimensions ____ plotted ____
Vegetable garden ✓ dimensions 12' X 20' plotted ____
Harb garden ____ dimensions ____ plotted ____
Dwarf fruit trees ____ kind ____ no. ____ plotted ____
Bush fruits ✓ kind strawberries no. ____ plotted ____
Vine fruits ____ kind ____ no. ____ plotted ____
Favorite plants ✓ kind Little Leaf Linden Tree
Lilac
Lily-of-the-Valley
Dogwood-white
something with lots of blooms
Ornaments ____ statuary ____ other ____ plotted ____
Coldframes ____ dimensions ____ plotted ____
Greenhouse ____ dimensions ____ plotted ____
Compost bin ____ dimensions ____ plotted ____
Garden storage: equipment - mower ____ sweeper ____
fertilizer spreader ____
hose ____ sprinkler ____
duster ____ sprayer ____
other ____ plotted ____
tools - spade ____ rake ____
hoe ____ hand tools ____
other ____ plotted ____
supplies - fertilizer ____ pest control ____ other ____ plotted ____

Bird watching:
Bird feeder ✓ hummingbirds plotted ____
Bird bath ____ plotted ____
Bird houses ____ plotted ____
Bird attracting shrubs ____ plotted ____

Pets:
Doghouse ____ dimensions ____
run dimensions ____ plotted ____
Other ____ dimensions ____
run dimensions ____ plotted ____

Activities	Needs
Laundry:	Lines - permanent _______ linear ft. _______ plotted _______ temporary _______ linear ft. _______ plotted _______
Storage:	Trash _______ no. containers _______ sq.ft. required _______ plotted _______ Trailers _______ dimensions required _______ plotted _______ Boat _______ dimensions required ___________ plotted _______ Other - specify ___________ sq.ft. required ______________ plotted _______

COST

Approximate landscaping allowance (based on about 10% of the market value of the house and land): $ 5,000.

Cost limitation set by client: from $ 3,000 to $ 4,000.

Execution period:

Years		Approximate cost per year		
1				
2	✓	$1,500	2,000/yr.	
3				
4				

Credit: Pennsylvania State University. Landscape Design (A Student Handbook). University Park, PA: College of Agriculture, Agricultural Experiment Station, Department of Agricultural Education, 1968.

SITE ANALYSIS

Location 000 Pinewood Ave. Lot No. ____ Date ________

Client Name Mr. & Mrs. Sam Somebody Telephone No. 555-6983

On Site Factors

Lot: Dimensions - length 114' width 48' plotted ____
Rights-of-way ____________ plotted ____
Easements ________ kind ________ plotted ____
Legal restrictions - setback 5' plotted ____
lot lines ________ plotted ____
corner obstruction ________ plotted ____
fence, setback ___ height 4'
length ____ type Chain link
outbuilding ________
trees not permitted -
boxelder (female) ✓ poplar ___
willow ___ other ________

Sidewalk: Installed concrete location plotted ____
Not installed ________ future location plotted ____
done by owner ____ city ____
Never to be installed ____ Contours plotted ____
Drainage - adequate ____ inadequate ____
install tile lines ________ plotted ____
Soil type - clay ___ loam ___ sand ___ muck ___
Soil sample taken ____
Soil test results - pH ___ N ___ P ___ Ca ___ other ____
Rock outcropping ________ plotted ____

Water : Spring ___ brook ___ pond ___ marsh ___ other ____ plotted ____

Existing vegetation:

Trees ✓ species	Bur Oak	height 6'	width 3'	plotted	____
	Red Maple	8'	3'		____
	____	____	____		____
Shrubs ✓ species	Densiformis Yews	height 3'	width 3'	plotted	____
	Pfitzer Juniper	4'	5'		____
	____	____	____		____
	____	____	____		____

Turf areas ________ plotted ____
satisfactory ____ renovate ____ replace ____
Bare soil ________ plotted ____

Structures: House ______ length ______ width ______ plotted ______
Front faces north ___ east ✓ south ___ west ___
other ______
Style ranch ______ color(s) ______
Material - brick ✓ frame ___ stone ___ other ______

Outer Buildings - length ______ width ______ plotted ______
Materials ______ plotted ______
Driveway ✓ width 10' length 38' material concrete
plotted ______
Walks ✓ width 3' length 28' material concrete plotted ______
Terraces ___ width ___ length ___ material ___ plotted ______

Climate: Hardiness zone 5 on plan ___ prevailing wind direction SW
on plan ___
Orientation - north indicated on plan ___ shade areas plotted ___
sunlight control area plotted ___
wind control area plotted ___
snowdrift control area plotted ___

Utilities: Overhead poles plotted ______ wires plotted ___
Underground water line ______ plotted ___
water valve ______ plotted ___
electric lines ______ plotted ___
electric meter ______ plotted ___
drainage lines ______ plotted ___
septic tank ______ drainage field ______ plotted ___
dry wells ______ plotted ___
gas line ______ plotted ___
gas valve ______ plotted ___
gas meter ______ plotted ___

Off Site Factors

Favorable views -

Kind	______	height	___	width	___	season	___	plotted ______
	______		___		___		___	______
	______		___		___		___	______
	______		___		___		___	______

Unfavorable views -

Kind	neighbor to SW	height	___	width	___	season	___	plotted ______
	______		___		___		___	______
	______		___		___		___	______
	______		___		___		___	______

Pedestrian traffic: Control needed ___ not needed ✓ pattern plotted ______

Noise: Control needed ______ area plotted ______

Dust: Control needed ______ area plotted ______

Bright lights: Car ___ parking ___ neighbor ___ other ______
area plotted ______

Credit: Pennsylvania State University. Landscape Design (A Student Handbook). University Park, PA: College of Agriculture, Agricultural Experiment Station, Department of Agricultural Education, 1968.

Lesson 5: Developing a Landscape Plan

Work Sheet 5.2: Developing a Landscape Plan

Design a landscape plan using a site chosen by one's teacher or oneself. Develop the landscape plan by using the four basic steps of:

1) **Complete analysis of family needs.**
2) **Complete site analysis**
3) **Sketch design concept**
4) **Draw the design solution**

ANALYSIS OF FAMILY NEEDS

Location ____________________ Lot No. ____ Date __________

Client Name ____________________ Telephone No. __________

Number of Children - Pre-school ______ Elementary ______ High School ________

Activities **Needs**

Entertaining:

Paved area - capacity (people) ______ size ______

color __________ material ______________ plotted _____

Shade - canopy ________ trellis ________

umbrella ________ tree ______________ plotted _____

Seating - benches _______ capacity _______

no. _______ style ______________ plotted _____

chairs ____ no. ______ style __________ plotted _____

chairs - folding _____ no. _____ style _____

storage ____________

tables _______ no. _______ style ________ plotted _____

table - dining ____ capacity ____ style _____

plotted _____

Garden lighting ___ kind ____ style _____ no. _____ plotted _____

Cooking:

Grill - permanent ____ size ____ style ____________ plotted _____

portable ___ size ____ style ______ storage plotted _____

Table - work ___ dimensions _____ style ___________ plotted _____

Storage for cooking _____ dimensions ______________ plotted _____

Electrical outlets ________ no. ________________ plotted _____

Games:

Croquet _____ dimensions 30' x 60' plotted _____

Badminton _____ dimensions 24' x 54' plotted _____

Bowling on the green _____ dimensions 10' x 50' or 20' x 100' plotted _____

Volleyball _____ dimensions 40' x 70' plotted _____

Basketball hoop _____ dimensions 40' x 40' plotted _____

Tetherball _____ dimensions 20' dia. circle plotted _____

Horseshoes _____ dimensions 20' x 40' plotted _____

Archery _____ dimensions 20' x 100' min. plotted _____

Putting green _____ dimensions 30' dia. circle min. plotted _____

Shuffleboard _____ dimensions 6' x 45' plotted _____

Other __________ dimensions ______________ plotted _____

Game storage _____ length _____ width _____ height _____

plotted _____

Playing:

Sandbox _____ dimensions ______________ plotted _____

Swings _____ dimensions ______________ plotted _____

Slide _____ dimensions ______________ plotted _____

Playhouse _____ dimensions ______________ plotted _____

Monkeybars _____ dimensions ______________ plotted _____

Wading pool _____ dimensions ______________ plotted _____

Blackboard _____ dimensions ______________ plotted _____

Other (specify) ____________ dimensions __________ plotted _____

Storage, wheel toys, etc. _____ dimensions ________ plotted _____ ctivities Needs

Swimming:
Pool _____ dimensions ____________ shape __________
material ______________________________________ plotted _____
Diving board _____ dimensions _____________________ plotted _____
Paved area _____ dimensions ______________________
material ______________________________________ plotted _____
Enclosure ____ plotted _____
Equipment storage _________________________________ plotted _____

Gardening:
Minimum maintenance ______________
Automatic watering system _________________________ plotted _____
Flower beds _____ annuals _____ perennials _____
roses _____ mixed ______________________________ plotted _____
Planter boxes _______________ kind _______________ plotted _____
Water garden _____ water lilies ____ fountain _____
dimensions _____________________________________ plotted _____
Cutting garden _____ dimensions ___________________ plotted _____
Vegetable garden _____ dimensions _________________ plotted _____
Harb garden _____ dimensions ______________________ plotted _____
Dwarf fruit trees ___ kind ______________ no. _____ plotted _____
______________ _____ _____
______________ _____ _____
Bush fruits _________ kind ______________ no. _____ plotted _____
______________ _____ _____
______________ _____ _____
Vine fruits _________ kind ______________ no. _____ plotted _____
Favorite plants _____ kind ________________________
____
____
____
Ornaments ____ statuary ___ other _________________ plotted _____
Coldframes ____ dimensions ________________________ plotted _____
Greenhouse ____ dimensions ________________________ plotted _____
Compost bin ____ dimensions _______________________ plotted _____
Garden storage: equipment - mower ____ sweeper ___
fertilizer spreader ____
hose ____ sprinkler ____
duster ____ sprayer ____
other ________________________ plotted _____
tools - spade ____ rake ____
hoe ____ hand tools ____
other ________________________ plotted _____
supplies - fertilizer ____ pest
control ____ other __________ plotted _____

Bird watching:
Bird feeder _______________________________________ plotted _____
Bird bath ____ plotted _____
Bird houses _______________________________________ plotted _____
Bird attracting shrubs ____________________________ plotted _____

ets:
Doghouse _____ dimensions _________________________
run dimensions _____________________________ plotted _____
Other _____ dimensions ____________________________
run dimensions _____________________________ plotted _____

Activities	Needs
Laundry:	Lines - permanent _______ linear ft. _______ plotted ________ temporary _______ linear ft. ________ plotted ________
Storage:	Trash _______ no. containers _______ sq.ft. required ________ plotted _______ Trailers _______ dimensions required _______ plotted ________ Boat _______ dimensions required ___________ plotted ________ Other - specify ____________ sq.ft. required ________________ plotted _______

- -

COST

Approximate landscaping allowance (based on about 10% of the market value of the house and land): $ ________________.

Cost limitation set by client: from $ ______________ to $ ______________.

Execution period:

Years	Approximate cost per year			
1 ______	___________			
2 ______	___________	___________		
3 ______	___________	___________	___________	
4 ______	___________	___________	___________	________

Credit: Pennsylvania State University. Landscape Design (A Student Handbook). University Park, PA: College of Agriculture, Agricultural Experiment Station, Department of Agricultural Education, 1968.

SITE ANALYSIS

Location ______________________________ Lot No. _____ Date __________

Client Name ____________________________ Telephone No. ____________

On Site Factors

Lot:
Dimensions - length _________ width __________ plotted _____
Rights-of-way _____________________________ plotted _____
Easements ____________ kind _______________ plotted _____
Legal restrictions - setback _______________ plotted _____
lot lines _______________ plotted _____
corner obstruction ________ plotted _____
fence, setback ___ height _____
length _____ type _____
outbuilding ____________
trees not permitted -
boxelder (female) ___ poplar ___
willow ___ other __________

Sidewalk:
Installed _______________________ location plotted _____
Not installed ______________ future location plotted _____
done by owner _____ city _____
Never to be installed _____ Contours plotted _____
Drainage - adequate _____ inadequate _____
install tile lines ___________________ plotted _____
Soil type - clay ___ loam ___ sand ___ muck ___
Soil sample taken _____
Soil test results - pH ___ N ___ P ___ Ca ___ other _____
Rock outcropping _______________________ plotted _____

Water :
Spring ___ brook ___ pond ___ marsh ___ other ___ plotted _____

Existing vegetation:

Trees ___	species	________	height	____	width	____	plotted _____
		________		____		____	_____
		________		____		____	_____
		________		____		____	_____
Shrubs __	species	________	height	____	width	____	plotted _____
		________		____		____	_____
		________		____		____	_____
		________		____		____	_____

Turf areas ___________________________ plotted _____
satisfactory _____ renovate _____ replace _____
Bare soil ____________________________ plotted _____

Structures: House ________ length ________ width ____________ plotted ______
Front faces north ____ east ____ south ____ west ____
other ___________
Style ______________________________ color(s) ______________
Material - brick ___ frame ___ stone ___ other _______

Outer Buildings - length ________ width __________ plotted ______
Materials ______________________________ plotted ______
Driveway _____ width _____ length ____ material _______
plotted ______
Walks ____ width _____ length _____ material _____ plotted ______
Terraces __ width ____ length _____ material _____ plotted ______

Climate: Hardiness zone ___ on plan ___ prevailing wind direction ___
on plan ___
Orientation - north indicated on plan ___ shade areas plotted ___
sunlight control area plotted ___
wind control area plotted ___
snowdrift control area plotted ___

Utilities: Overhead poles plotted ______________________ wires plotted ___
Underground water line ______________________ plotted ___
water valve ______________________ plotted ___
electric lines ______________________ plotted ___
electric meter ______________________ plotted ___
drainage lines ______________________ plotted ___
septic tank ______ drainage field __________ plotted ___
dry wells ______________________ plotted ___
gas line ______________________ plotted ___
gas valve ______________________ plotted ___
gas meter ______________________ plotted ___

Off Site Factors

Favorable views -
Kind ____________________ height ____ width ____ season _____ plotted ______
____________________ ____ ____ _____ ______
____________________ ____ ____ _____ ______
____________________ ____ ____ _____ ______

Unfavorable views -
Kind ____________________ height ____ width ____ season _____ plotted ______
____________________ ____ ____ _____ ______
____________________ ____ ____ _____ ______
____________________ ____ ____ _____ ______

Pedestrian traffic: Control needed _____ not needed _____ pattern plotted ______

Noise: Control needed ______________________ area plotted ______

Dust: Control needed ______________________ area plotted ______

Bright lights: Car ___ parking ___ neighbor ___ other ________
area plotted ______

Credit: Pennsylvania State University. Landscape Design (A Student Handbook). University Park, PA: College of Agriculture, Agricultural Experiment Station, Department of Agricultural Education, 1968.

UNIT XII - DEVELOPING COST ESTIMATES

Lesson 1: Pricing the Design

Objective: The student will be able to figure a cost analysis.

Study Questions

1. **What is the difference between a cost estimate and a bid?**
2. **What is included in the price of a landscape design?**
3. **What are landscape specifications?**
4. **What are the features of a cost estimate?**
5. **How is a cost estimate prepared?**
6. **Who benefits from a cost estimate?**
7. **How is the quantity of materials determined for a landscape design?**

References

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
2. Transparency Master
    a) TM 1.1: Cost Estimate Sheet
3. Work Sheets
    a) WS 1.1: Figuring Volume
    b) WS 1.2: Cost Estimate Sheet

UNIT XII - DEVELOPING COST ESTIMATES

Lesson 1: Pricing the Design

TEACHING PROCEDURES

A. Introduction

Landscape designers must know how to price designs in order to have a successful business. Knowing how to prepare bids or cost estimates for clients is essential in this process.

B. Motivation

Calculating the price of landscape designs will satisfy clients because they will know what they are spending for the materials and services received. It will satisfy the designers because they will know their profits.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students if they know the difference between an estimate and a bid in the construction industry.

   What is the difference between a cost estimate and a bid?

   a) Cost estimate - an approximation of the final cost
   b) Bid - a firm price set by the company that includes all cost involved

2. Tell students to imagine that they own their own business. Ask them what would be important factors in setting the price of their product.

   What is included in the price of a landscape design?

   a) The total of
      1) Material costs
      2) Labor costs
      3) Equipment costs
      4) Subcontracted work

3. Ask students how they know the quality of an item before purchasing it.

   What are landscape specifications?

   Specifications are an exact list of quality standards to be used for each material and procedure in the landscape design.

4. Ask students what some basic steps are in following a recipe.

   What are the features of a cost estimate?

- a) Cost of materials
- b) Labor costs
- c) Equipment rental
- d) Subcontracted work

5. Ask students what some steps are in preparing a budget. Use TM 1.1, Cost Estimate Sheet.

   How is a cost estimate prepared?

   - a) Fill out name, address, and other information about client and job site. Also, estimate starting and finishing dates.
   - b) Materials
     - 1) Materials used - description
     - 2) Quantities of each - number of units required
     - 3) Cost of each - cost/unit
     - 4) Total - total cost
   - c) Labor
     - 1) Number of employees - description
     - 2) Estimated number of hours - number of units required
     - 3) Cost per worker per hour
     - 4) Frequently a standard percentage of the materials cost is charged.
   - d) Equipment
     - 1) List equipment owned or rented - description
     - 2) Number of hours or days - number of units required
     - 3) The rate per hour or day - cost/unit
     - 4) Totals - total cost
   - e) Subcontracted work
     - 1) Subcontractor - description
     - 2) Hours or days worked - number of units required
     - 3) Rate paid for work - cost/unit
     - 4) Totals - total cost
   - f) Subtotal - add everything but labor
   - g) Tax - according to local rate
   - h) Total of the entire estimate

6. Ask students who benefits when an item is purchased.

   Who benefits from a cost estimate?

   - a) The client knows total cost of the design.
   - b) The business knows all costs are covered.

7. Ask students how to figure amounts of food needed for a dinner in order to serve six people.

   How is the quantity of materials determined for a landscape design?

   - a) Figure area-length x width.
   - b) Figure volume or quantity-length x width x depth.
     - 1) Convert to all the same units of measure.
     - 2) Convert to the units (cubic feet or yards) in which material is sold.

F. Other Activity

Ask a representative from a landscape firm to come in and talk about pricing a design.

G. Conclusion

The price of a landscape design can be written as a cost estimate or a bid. All specifications must be written in the cost analysis. Other information found on a cost analysis sheet are: subcontracted work, materials used, labor, and equipment. Figuring quantities needed is important in determining total cost. Both the client and the landscape firm benefit from a cost analysis.

H. Competency

Calculate the price of a landscape design.

I. Answers to Evaluation

1. a
2. b
3. b
4. c
5. a

J. Answers to Work Sheet

WS 1.1

1. Drive 45' x 15' x .333' = 224.78 cu. ft.
   Walk 25' x 5' x .333' = 41.63 cu. ft.
   224.78 + 41.63 = 266.41
   266.41 cu. ft. x $\frac{\text{1 cu. yd.}}{\text{27 cu. ft.}}$ = 9.87 cu. yd.

2. Take the rectangular shape of the back yard and subtract the area of the house (the part in the back yard), deck, and raised bed.

   entire area of back yard = 85' x 60' = 5,100 sq. ft.
   portion of house in back yard = 20' x 20' = 400 sq. ft.
   deck area = 1. 20' x 20' = 400 sq. ft.
   2. 20' x 5' = 100 sq. ft.
   3. $\frac{3.14 \times (7\text{ ft.})^2}{4}$ = 38.5 sq. ft.
   raised bed = 40' x 5' = 200 sq. ft.

   5,100 - (400 + 400 + 100 + 38.5 + 200) = 5,100 - 1138.5 = 3,961.5 sq. ft.

3. L x W x Depth = 40' x 5' x 1.5' = 300 cu. ft.
   300 cu. ft. x $\frac{\text{1 cu. yd.}}{\text{27 cu. ft.}}$ = 11.11 cu. yd.
4. Area = πr^2
   $3.14 \times (1.5')^2 = 3.14 \times 2.25$ sq. ft. = 7 sq. ft.
   7 sq. ft. x .17 ft. = 1.19 cu. ft.
5. 11.5" x 20'/1" = 230.0 ft.

WS 1.2 - A sample answer is provided on the following page.

LANDSCAPE COST ESTIMATE SHEET

CUSTOMER INFORMATION:
NAME: Kelly Anybody HOME PHONE: 314-555-1798
ADDRESS 10 High St. WORK PHONE: 314-555-2990
CITY: Anytown STATE: MO ZIP: 65203

NAME OF ESTIMATOR: Students Name TODAY'S DATE: / /
ESTIMATED STARTING DATE: / / ESTIMATED FINISH DATE: / /

	UNITS	DESCRIPTION	COST/UNIT		TOTAL COST	
MATERIALS:						
1.	15lbs	Lime		07	1	05
2.	15lbs	Fertilizer		45	6	75
3.	10yd^3	Mulch	3	10	31	00
4.	5	Zebra Plants	6	99	34	95
5.	1	White Dogwood	38	50	38	50
6.	13	Emerald Gold Euonymus	11	75	152	75
7.	4	Densiformis Yew	22	00	88	00
8.		Materials Subtotal			353	00
9.						
10.						
11.						
12.						
LABOR:						
13.						
14.	2hrs	Flower Bed Preparation	12	00	24	00
15.		Planting Labor			141	20
16.		(40% of Material Costs)				
17.						
EQUIPMENT:						
18.	2hrs	Rototiller Rental	8	00	16	00
19.						
SUBCONTRACTED WORK:						
20.		None				
21.						
22.						
SUBTOTAL					534	20
TAX			@ (6.5 %)		34	72
TOTAL COST ESTIMATE (WITHIN 15%):					568	92

UNIT XII - DEVELOPING COST ESTIMATES

Name ____________________

Lesson 1: Pricing the Design

Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. What is a binding agreement between client and landscape company called?

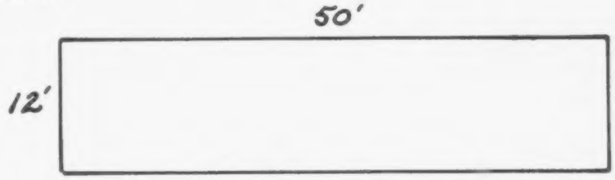
   a) Bid
   b) Cost estimate
   c) Legal statement
   d) Price

2. Which is not a feature of a cost estimate?

   a) Plant materials
   b) Kind of truck used
   c) Subcontracted work
   d) Labor costs

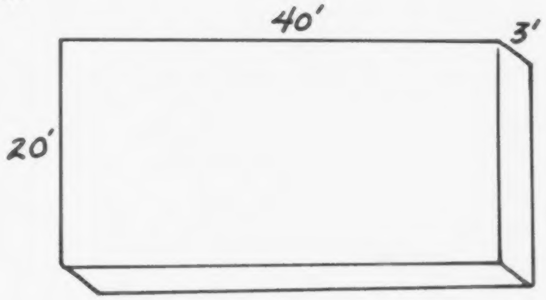
3. What is the area of the design below?

   a) 600 ft.
   b) 600 sq. ft.
   c) 600 cu. ft.
   d) 600 cu. yds.



4. What is the volume of the area below?

   a) 240 ft.
   b) 240 sq. ft.
   c) 2,400 cu. ft.
   d) 2,400 cu. yds.



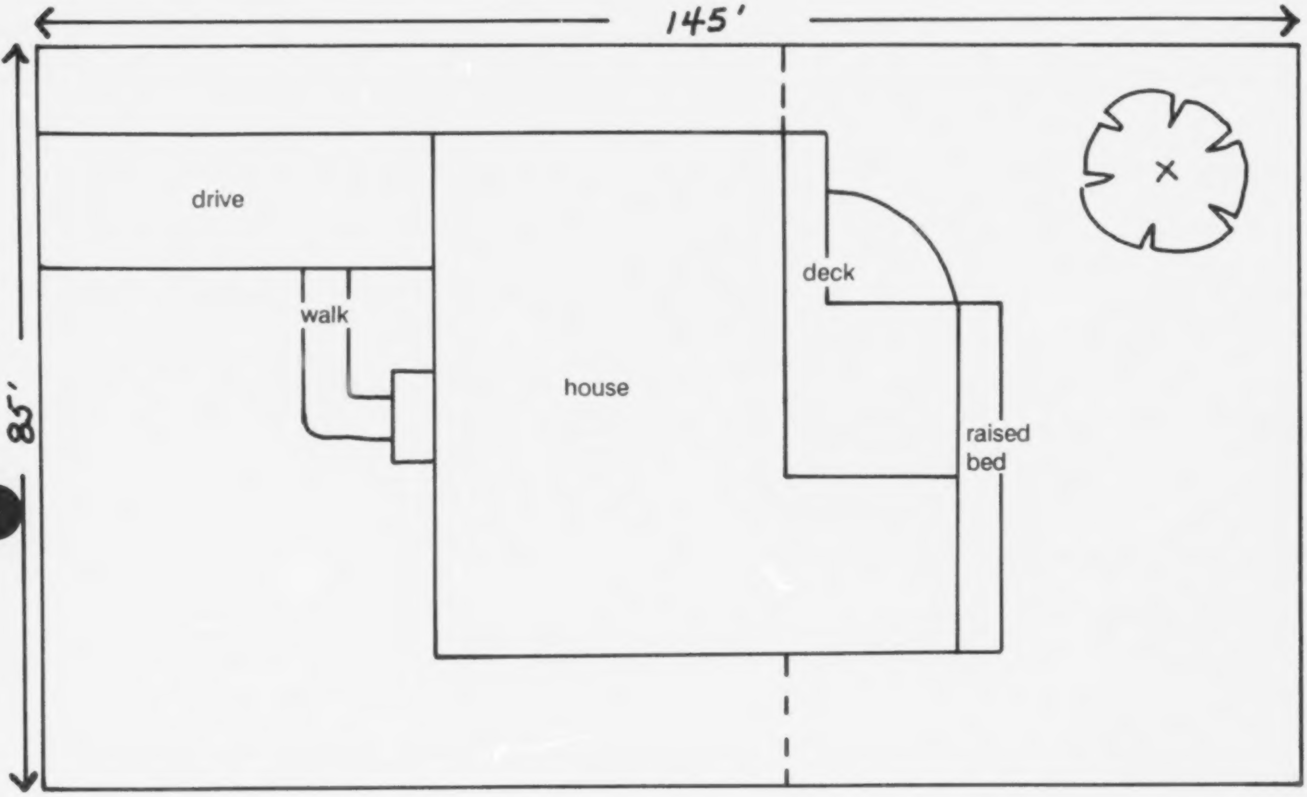
5. Which of the following is not an overhead cost?

   a) Plant materials
   b) Rent
   c) Salaries
   d) Utilities

Lesson 1: Pricing Design

Work Sheet 1.1: Landscaping-Area/Volume Exercise

Using the landscape plan provided, answer the questions below. Scale is 1" = 20'. (Show your work.)



1. How many cubic yards of concrete are needed to pour the driveway and sidewalk 4" deep? Do not include landing.

2. You want to plant grass seed in the back lawn, but you need to know what the area is in order to buy the grass seed. You plan to plant seed under the tree. How many square feet are in the back lawn?

3. How many yards of soil would be needed to fill the raised bed, by the deck, with 18" of topsoil?

4. How many cubic feet of bark mulch will be needed to put a 3' diameter ring 2" deep around the tree in the backyard?

5. How many linear feet of privacy fencing would be required to enclose the back lawn?

Lesson 1: Pricing the Design

Work Sheet 1.2: Cost Estimate Sheet

Place the information correctly onto the cost estimate sheet located on the back of this page and calculate the total estimate.

Customer is Joseph M. Gardener at 1667 Meadow Lane, Mihome, Missouri, 66523. Work Phone is 555-9934 and Home Phone is 555-4321.

Estimated starting date will be 10 days from today and it should be completed in one day.

1. Sales Tax 6.5%
2. Labor for 2 hours of flower bed preparation at $12.00/hour
3. Labor for general plantings will equal 40% of the total material bill before taxes
4. Lime 15 pounds at 7 cents a pound
5. White dogwood - potted at $38.50 each
6. 13 Emerald Gold Euonymus at $11.75 each
7. 10 cubic yard bags of mulch at $3.10/bag
8. No subcontracted work
9. Fertilizer at $.45/pound, for 15 pounds
10. 5 Zebra plants at $6.99 each
11. 4 densiformis yews at $22.00 each
12. 2 hours of rototiller rental at $8.00/hour

Remember to total the estimate.

LANDSCAPE COST ESTIMATE SHEET

CUSTOMER INFORMATION:
NAME: ____________________ HOME PHONE: ____________________
ADDRESS ____________________ WORK PHONE: ____________________
CITY: ____________________ STATE: __________ ZIP: __________

NAME OF ESTIMATOR: ____________________ TODAY'S DATE: ____________________
ESTIMATED STARTING DATE: ____________________ ESTIMATED FINISH DATE: ____________________

UNITS		DESCRIPTION	COST/UNIT	TOTAL COST	
MATERIALS:					
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
LABOR:					
13.					
14.					
15.					
16.					
17.					
EQUIPMENT:					
18.					
19.					
SUBCONTRACTED WORK:					
20.					
21.					
22.					
SUBTOTAL					
TAX			@ (________ %)		
TOTAL COST ESTIMATE (WITHIN 15%):					

UNIT XII - DEVELOPING COST ESTIMATES

Lesson 2: Pricing Landscape Maintenance

Objective: The student will be able to price the various components of landscape maintenance.

Study Questions

1. **Why is a cost analysis needed in landscape maintenance?**
2. **What tasks are involved in landscape maintenance?**
3. **What are the seven features of the landscape maintenance cost analysis?**
4. **How are labor costs determined?**

References

1. Landscaping and Turf Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
2. Work Sheet
    a) WS 2.1: Labor Costs

Lesson 2: Pricing Landscape Maintenance

TEACHING PROCEDURES

A. Review

Review the previous lesson.

B. Motivation

Understanding the factors involved in preparing a cost analysis for landscape maintenance will help ensure that a profit will be made.

C. Assignment

D. Supervised study

E. Discussion

1. Ask students why it would be important to establish a cost for services before performing them?

Why is a cost analysis needed in landscape maintenance?

a) Permits a fair price to be charged to the customer
b) Can compare the efficiency of different crews in performing the same task
c) Ensures that all costs to the firm are covered
d) Allows comparison of the profitability of different tasks

2. Ask students what types of tasks are involved in maintaining their own yards.

What tasks are involved in landscape maintenance?

a) Mow lawn.
b) Prune trees and shrubs.
c) Apply fertilizer to lawn and plantings.
d) Control weeds in lawn and plantings.
e) Spray and/or dust to control insects and diseases.
f) Plant and care for flower beds and borders.
g) Replace dead plants.
h) Paint or stain outdoor furnishings.
i) Repair walls and paved surfaces.
j) Clean fountains and pool basins.
k) Irrigate lawn.
l) Cultivate soil around trees and shrubs.
m) Replace mulches.
n) Remove lawn thatch.
o) Roll and reseed lawn.
p) Rake leaves in fall.
q) Winterize trees and shrubs.
r) Remove snow.

s) Perform preventative maintenance on equipment.

3. Ask students what cost analysis is.

What are the seven features of the landscape maintenance cost analysis?

a) A listing of all tasks to be performed
b) The total square footage area involved for each service
c) The number of times each service is performed during the year
d) The time required to complete each task once
e) The time required to complete each task annually
f) The cost of all materials required for each task
g) The cost of all labor required for each task

4. Ask students students how hourly wages are calculated.

How are labor costs determined?

a) Divide hour into ten parts, e.g. 0.1 = six minutes
b) Determine hours worked, e.g., 45 minutes worked
45 min. ÷ 60 min./hr. = .75 hours worked
.75 x hourly rate ($5.50)
.75 x $5.50 = $4.13 labor cost

F. Other Activity

Have someone from a landscape maintenance firm discuss cost analysis.

G. Conclusion

Cost analysis can also be used with landscape maintenance. It benefits the client as well as the landscape firm. Many tasks, from mowing the lawn to snow removal, are included in a cost analysis. Wages are also calculated and added to the cost analysis.

H. Competency

Price various components of landscape maintenance.

I. Answers to evaluation

1. c
2. a
3. a
4. b

J. Answers to Work Sheet

1.	$7.50	6.	$38.14
2.	$15.75	7.	$49.00
3.	$40.80	8.	$10.30
4.	$26.68	9.	$2.50
5.	$27.00	10.	$37.70

UNIT XII - DEVELOPING COST ESTIMATES

Lesson 2: Pricing Landscape Maintenance

Name ____________________

Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which is not a task in regular landscape maintenance?

   a. Mow lawn.
   b. Prune trees and shrubs.
   c. Sow seed.
   d. Spray and/or dust to control insects.

2. Which is not a feature of a maintenance cost analysis?

   a. List of all tasks to be completed
   b. Cost of all materials
   c. Cost of repairing mistakes made by workers
   d. Time required to complete each task

3. What is the total salary if wages are $4.85 per hour and the employee has worked 5 1/2 hours?

   a. $26.68
   b. $28.46
   c. $31.25
   d. $32.89

4. What is not a benefit of using cost analysis in landscape maintenance?

   a. Customer will be charged fair price.
   b. The landscape design can easily be changed.
   c. Landscape firm costs are acknowledged.
   d. Efficiency crew performances can be measured.

UNIT XII - DEVELOPING COST ESTIMATES WS 2.1

Lesson 2: Pricing Landscape Maintenance

Work Sheet 2.1: Labor Costs

1 hour = 10 units
1/10 hour = .1 or 6 minutes

Example:

> wage: $5.50 per hour, worked 45 min.
>
> $$45 \text{ min.} \times \frac{1 \text{ hr.}}{60 \text{ min.}} = .75 \text{ hrs.}$$
>
> .75 hrs. x $5.50 = $4.13

Calculate the total salary for the following.

1. Wage: $5.00 hours worked: 1 1/2 hours Total Salary:________
2. Wage: $5.25 hours worked: 3 hours Total Salary:________
3. Wage: $5.10 hours worked: 8 hours Total Salary:________
4. Wage: $4.85 hours worked: 5 1/2 hours Total Salary:________
5. Wage: $6.00 hours worked: 4 1/4 hours Total Salary:________
6. Wage: $5.65 hours worked: 6 3/4 hours Total Salary:________
7. Wage: $4.90 hours worked: 10 hours Total Salary:________
8. Wage: $5.15 hours worked: 2 hours Total Salary:________
9. Wage: $5.00 hours worked: 1/2 hours Total Salary:________
10. Wage: $5.20 hours worked: 7 1/4 hours Total Salary:________

MISSOURI AGRICULTURAL EDUCATION

10-2706-S

Landscaping and Turf Management

Student Reference

In cooperation with
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Department of Practical Arts
and Vocational-Technical Education
College of Education and College of Agriculture
University of Missouri-Columbia

IMI

In cooperation with
Agricultural Education Section
Division of Vocational and Adult Education
Department of
Elementary and Secondary Education
Jefferson City, Missouri

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Student Reference

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FOREWORD

The development of the Landscaping and Turf Management guide is the result of suggestions by the MVATA Teaching Aids Committee. The Landscaping and Turf Management Advisory Committee suggested the topics to be discussed and reviewed the materials.

This student reference and the corresponding instructor guide contain 12 units, which cover a wide range of topics including: opportunities in the landscaping and turfgrass industries; how plants grow; hand and power tools; installation and maintenance of trees, shrubs, bedding plants, and ground covers; turfgrass; site analysis and evaluation; plant identification and selection; design elements; and cost estimates. See the table of contents for a detailed listing. Plant identification and selection tables are located only in the student reference.

Those using this publication on an individual basis may want to obtain a copy of the instructor guide, which contains additional information.

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University of Missouri-Columbia

Terry Heiman, Director
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Secondary Education

LANDSCAPING AND TURF MANAGEMENT

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Ornamental horticulture is the branch of horticulture that has to do with the growth and the improvement of the environment. The landscape and turfgrass industries are two areas of ornamental horticulture that have become increasingly important.

Effects of Plants on People and the Environment

Plants affect people and their environment. Gardens have always been a source of pleasure for people that continues today. Plants can produce many psychologically uplifting effects on people. They can give people feelings of comfort and relaxation. Pride and pleasure result from well-maintained gardens or yards. A plant-filled area can be a pleasant place to entertain or to seek refuge from the pressures of a busy workday. Plants also provide long-range enrichment to the environment by increasing the economic value of a home as well as the natural ecosystem of the area. Plants also add a reflection of personal taste to the environment.

Property Value

Landscaping, can increase property value as well as provide greater use and beauty of the property. Landscaping is not an unnecessary expense, but a capital investment. Good landscaping could add approximately 10-15 percent to the value of property, with a slight increase of this value, as plants mature. A house with a landscaped yard is always more appealing than one without. This might be an important factor in the sale of a home.

Landscaping can provide security on property by providing lighting, screening, and fencing. Home heating and cooling energy can be saved by planting native plants, sunscreens, and wind blocks.

Landscaping also increases the beauty of property and creates an attractive environment for the owners. An attractive landscape may also give a pleasant impression to neighbors, as well as fill the owner with a sense of pride.

Economic Value

The economic value of the landscape and turfgrass industries has been increasing steadily since the 1960's. The national figures show that the landscape and turfgrass industries, within the past seven years, have gone from generating under one billion dollars to over seven billion dollars. These industries are really just beginning to emerge and are a very important part of the national economy.

Future

Recent surveys reveal that landscaping is a field of the future. It is an industry that will continue to grow. People are taking notice of what their environment looks like. They are desiring unspoiled, natural, recreation areas. City people want landscapes with beautiful, colorful plants amid the concrete and stone. People are expanding cities by moving to newly-developed suburbs that need landscaping. People are more concerned today with their health, and feel that plants can aid in creating a feeling of relaxation, as well as help provide physical exercise required by gardening and yard work.

The turfgrass industry is also expanding with installation and maintenance of athletic fields, golf courses, cemeteries, and parks. Today, landscape and turfgrass industries are rapidly expanding and creating new markets for employment. With rapid changes of the recent past, and innovations for the future, new careers will continue to be created within the landscape and turfgrass industries. Electronics, computers, and telecommunications will allow people to stay home to work rather than travel to an office. New types of home landscaping, coordinating work and relaxation in one environment, will be created for the landscape and turfgrass industries. Because people are living longer today, there is an increase in designing landscapes for retirement homes. With a growing population of single adults, there is an increase of condominiums and recreational areas for singles; both require landscape services. Theme parks, recreational parks, and shopping centers are being remodeled with landscaping as well.

Summary

Plants can have a pleasant, psychological effect on people. Plants help to create a feeling of enjoyment and relaxation. Landscaping is not as much an expense as an investment. It increases the economic value of the property as well as security, use, and beauty. The future is bright for the landscape and turfgrass industries. Athletic fields are always in use and in constant need of repair. Golf has been increasing in popularity within the past few years. Cemeteries will always be in need of turfgrass maintenance. Also, city, county, state, and national parks are visited daily by thousands of people, therefore creating the need for constant maintenance.

Credits

Cooperative Extension Service. Residential Landscape Design. Manhattan, KS: Kansas State University.

Ingels, Jack E. Landscaping. 3rd ed. Albany: Delmar Publishers, 1988.

Ingles, Jack E. Ornamental Horticulture Principles and Practices. 1st ed. Albany: Delmar Publishers, 1985.

Landscape Design. University Park, PA: Pennsylvania State University, 1968.

Moore, Gary E. and Wm. B. Richardson. Working in Horticulture. New York: Gregg Division/McGraw-Hill Book Co., 1980.

Horticulture is an expanding industry and that will continue to expand in the future, particularly in the areas of landscaping and turf management. Today, many people are too busy to maintain their yards. Therefore, they will be employing those in service jobs to improve and maintain their yards.

Common Jobs

There are many jobs and careers available in the landscape and turfgrass industries. The amount of training and education applicants have determine the types of jobs available to them. There are many entry-level jobs which require two or more years of training. Professional careers require a bachelor's degree, and in some cases, a master's degree.

Experience and training can be gained in two ways. The first is by doing a specific task, thus, learning by doing. The other way is to learn why something is done a certain way, as well as by doing it. These skills are taught in on-the-job training, apprenticeships, trade schools, two-year community colleges, and four-year universities. Technical and professional jobs require formal education as well as experience.

There are other areas of job opportunities in landscaping besides maintenance and professional areas. For example, one might work in sales and/or service for a corporation such as Dow or Ortho chemical companies. Another career possibility might be owning a landscape or turfgrass business. It requires not only knowledge of the horticulture industry but also business knowledge in order to operate a profitable, successful business.

Entry-Level Positions Available with High School/Vocational Training

1. Tree maintenance employee
2. Golf course employee
3. Landscape gardener
4. Grounds maintenance employee
5. Garden center employee

Entry-Level Positions Available with Bachelor's Degree

1. Tree maintenance foreman
2. Landscape foreman
3. Park system foreman
4. Garden center assistant manager
5. Garden center specialist
6. Golf course greens manager
7. Landscape architect/designer
8. Horticulture teacher

Positions Available with Master's Degree

1. Horticulture extension agent
2. Research scientist
3. Plant breeder

Following is a brief description of three, entry-level positions available to a high school graduate with two years of vocational training.

Garden center employee - A garden center employee position requires two years of training and experience in working with plants. A garden center employee will water, fertilize, and spray ornamental plants. Working with customers is also part of the job description.

Landscape gardener/maintenance employee - A landscape gardener is another position that requires at least two years of training and experience in horticulture. A gardener provides necessary care to plants after they are installed; including pruning, fertilizing, watering, weeding, planting, and replacement. A gardener must genuinely appreciate plants in order to provide the care required to maintain them.

Assistant greenskeeper - An assistant greenskeeper must have some knowledge about and experience in working with turf. An assistant greenskeeper assists in the general maintenance of a golf course; including mowing, watering, fertilizing, spraying, and installing turf.

Job descriptions of two, entry-level positions available to a college graduate follow.

Landscape architect - A landscape architect is someone who designs any outdoor space. Most states require landscape architects to be certified and licensed. Certification is obtained by attending a four-year university program accredited by the American Society of Landscape Architecture, with a period of apprenticeship following graduation. To become licensed, the landscape architect must pass a state licensing exam.

Landscape designer - In some states, a landscape designer must fulfill the same requirements as a landscape architect. In other states, the landscape designer must attend a two- or four-year college program in either landscaping or ornamental horticulture. However, there are a few states with no specific educational requirements for landscape designers.

Job Search

A job search is no easy task. It is time-consuming and, at times, frustrating. To aid in a job search, one may write out career goals. These career goals, along with a list of skills, weaknesses, and strengths will help in selecting the right job.

The job hunt can begin by telling one's friends and relatives that a job is being sought. They may have good ideas to help in this process. A horticulture teacher may also be able to assist and may know of available horticulture jobs. Another way to find a job is by looking in a classified section of a newspaper. The yellow pages of the phone book may supply names of horticulture businesses, their addresses, and phone numbers. Employment agencies and school guidance and placement services can also help in a job search. Other ideas might include placing an ad in a newspaper stating one's skills and listing a phone number for a potential employer to call for further information.

Supervised Agricultural Experience Program

A good way of learning landscaping and turf management by hands-on experience is to have a supervised agricultural experience program (SAEP). There are a number of different kinds of SAEP's that can be used. Some ideas might include:

1. Mowing and other summer maintenance jobs
2. Creating and implementing landscape designs
3. Raking leaves in fall and other maintenance jobs for winterization of plants
4. Maintaining lawn equipment for individuals in the community
5. "Lawn sitting" for homeowners on vacation
6. Performing jobs at a local nursery, garden center or golf course
7. Snow plowing and shoveling during winter

Professional Organizations

Professional organizations are made up of professionals bound together by specific fields. The landscape and turfgrass industries each have professional organizations. There are benefits of belonging to a professional organization. The number of meetings held depends on the organization. These meetings help update professionals by sharing new information in their field as well as current research. In addition, belonging to a professional organization provides opportunities for meeting new business contacts. Some professional organizations also provide group insurance programs. The following are professional organizations related to the landscape and turfgrass industries.

LANDSCAPING

American Institute of Landscape Architects
602 E. San Juan Ave.
Phoenix, AZ 85102

American Society of Landscape Architects
1733 Connecticut Ave. NW
Washington DC 20009

Associated Landscape Contractors of America
405 N. Washington St.
Falls Church, VA 22046

Council of Tree and Landscape Appraisers
1250 I Street NW
Suite 504
Washington DC 20005

National Landscape Association
2000 L Street NW
Suite 200
Washington DC 20036

Landscape Materials Information Service
Callicoon, NY 12723

NURSERY

Southern Nurserymen's Associaton
3813 Hillsboro Rd.
Nashville, TN 37215

Garden Centers of America
230 Southern Bldg.
15th and H Street NW
Washington DC 20005

Council of Tree and Landscape Appraisers
1250 I Street NW
Suite 504
Washington DC 20005

National Bark Producers Association
301 Maple Ave. W
Tower Suite 504
Vienna, VA 22180

American Association of Nurserymen, Inc.
1250 I Street NW
Suite 500
Washington DC 20005

Mail Order Association of Nurserymen, Inc.
210 Cartwright Blvd.
Massepequa Park, NY 11762

Wholesale Nursery Growers of America, Inc.
2000 L Street NW
Suite 200
Washington DC 20036

The International Plant Propagator's Society
2295 Hillsdale Way
Box 3131
Boulder, CO 80303

Wholesale Nursery Growers Association of America
230 Southern Bldg.
Washington DC 20005

Missouri Association of Nurserymen
Sarah Woody Bibens
Executive Secretary
Rt. 1, Box 175
Clarksdale, MO 64430

Wholesale Nursery Growers of America
230 Southern Building
Washington, DC 20005

Western Association of Nurserymen
2215 Forest Lane
Kansas City, KS 66106

Nursery Association Executives
Box 1871
Bozeman, MT 59715

National Christmas Tree Association
611 East Wells Street
Milwaukee, WI 53202

TURF

Sports Turf Managers Association
1458 N. Euclid Ave.
Ontario, CA 91764

Professional Grounds Management Society
3701 Old Court Rd.
Suite 15
Pikesville, MD 21208

Golf Course Superintendents Association of America
1617 St. Andrews Dr.
Lawrence, KS 66046-9990

United States Golf Association
Golf House
Far Hills, NJ 87931

American Sod Producers Association
1855-A Hicks Rd.
Rolling Meadows, IL 60008

National Lawn and Garden Distributors Association
1900 Arch St.
Philadelphia, PA 19103

American Sod Producers, Inc.
4415 W. Harrison
Hillside, IL 60162

Better Lawn and Turf Institute and The Lawn Institute
991 W. Fifth St.
Marysville, OH 43040

Professional Lawn Care Association
1225 Johnson Ferry Rd.
Suite B
Marietta, GA 30067

Professional Grounds Management Society
7 Church Lane
Suite 13
Pikesville, MD 21208

American Seed Trade Association
1030 15th St. SW
Suite 964
Washington DC 20005

Missouri Valley Turfgrass Association
c/o Terry Turner
University of Missouri
344 Hearnes Center
Columbia, MO 65211

Mississippi Valley Golf Course Superintendents Association
c/o Dennis O'Brien
Quail Creek C.C.
1432 Trails Ct.
Fenton, MO 63026

Trade Publications

A trade publication is a magazine that contains articles written for specific fields. Each area in horticulture has its own trade publications. Trade publications supply a great deal of information to the reader, such as up-to-date information concerning research reports, new products in the field, association news, industry information, and upcoming events. The following are trade publications related to the landscape and turfgrass industries.

Landscape Architecture
Schuster Bldg.
1500 Bardstown Rd.
Louisville, KY 40205

Landscape Design and Construction
2048 Cotner Ave.
Los Angeles, CA 90025

Landscape Industry
850 Elm Grove Rd.
Elm Grove, WI 53122

Midwest Landscaping
1706 W. Chase St.
Chicago, IL 60626

Western Landscaping News
1623 S. Lacienega Blvd.
Los Angeles, CA 90035

Landscape Management
9800 Detroit Ave.
Cleveland, OH 44102

Golf Course Management
1617 St. Andrews Dr.
Lawrence, KS 66046-9990

Green Section Record
Golf House
Far Hills, NJ 07931

Turf News
1855-A Hicks Rd
Rolling Meadows, IL 60008

Quarterly Newsletter
Missouri Valley Turfgrass Association
University of Missouri
344 Hearnes Center
Columbia, MO 65211

Newsletter: The Gateway Green
Mississippi Valley Golf Course Superintendents Association

Quail Creek C.C.
1432 Trails Ct.
Fenton, MO 63026

Grounds Maintenance
1014 Wyandotte St.
Kansas City, MO 64105

Lawn/Garden/Outdoor Living
1014 Wyandotte St.
Kansas City, MO 64108

Turf Grass Times
218 19th Ave.
N. Jacksonville Beach, FL 32050

Landscape Management (Weeds, Trees, and Turf)
9800 Detroit Ave.
Cleveland, OH 44102

American Nurseryman
310 S. Michigan Ave.
Chicago, IL 60604

Arborist News
P.O. Box 426
Wooster, OH 44691

Florist and Nursery Exchange
434 S. Wabash Ave.
Chicago, IL 60605

Pacific Coast Nurserymen and Garden Center Dealer
832 S. Baldwin Ave.
Arcadia, CA 91007

Nursery Product News
9800 Detroit Ave.
Cleveland, OH 44102

Nursery Business
850 Elm Grove St.
Elm Grove, WI 65122

Modern Garden Center
208 James St.
Barrington, IL 60010

Northwest Garden Supplier
311 Henry Bldg.
Portland, OR 97204

Southern Florist and Nurserymen
P.O. Box 1868
Fort Worth, TX 76101

Home and Garden Supply Merchandisers
2501 Wayzata Blvd.
P.O. Box 67
Minneapolis, MN 55440

Garden Industry of America
Box 1092
Minneapolis, MN 55440

Summary

Horticulture is an expanding field offering great potential for future jobs in the landscape and turfgrass industries. Membership in professional organizations, as well as subscribing to trade publications, help keep those in horticultural positions up-to-date on new information in the field, research, new products, and may provide business contacts.

Credits

Cooperative Extension Service. Residential Landscape Design. Manhattan, KS: Kansas State University.

Ingles, Jack E. Landscaping. 3rd ed. Albany: Delmar Publishers, 1988.

Ingles, Jack E. Ornamental Horticulture Principles and Practices. 1st ed. Albany: Delmar Publishers, 1985.

Landscape Design. University Park, PA: Pennsylvania State University, 1968.

Moore, Gary E. and William B. Richardson. Working in Horticulture. New York: Gregg Division/McGraw-Hill Book Co., 1980.

Snyder, Leon. Interview. University of Missouri-Columbia, Horticulture Department.

Starbuck, Chris. Interview, University of Missouri-Columbia, Horticulture Department.

Every plant in our environment serves a purpose. Not only do plants provide food and oxygen, they have aesthetic value as well. Landscapers put plants in the most beneficial and pleasing locations. In order to do this, they must know that plants serve different purposes and grow in different ways. Monocot and dicot plants differ in growth habits. These differences allow them to serve unique purposes in a landscape.

Monocot and Dicot Plants

The basic plant parts are leaves, stems, roots, and flowers (which later turn into fruit or seeds). Since individual plants differ in structure of the basic plant parts, they can be categorized as either monocot or dicot plants. See Figure 1.1

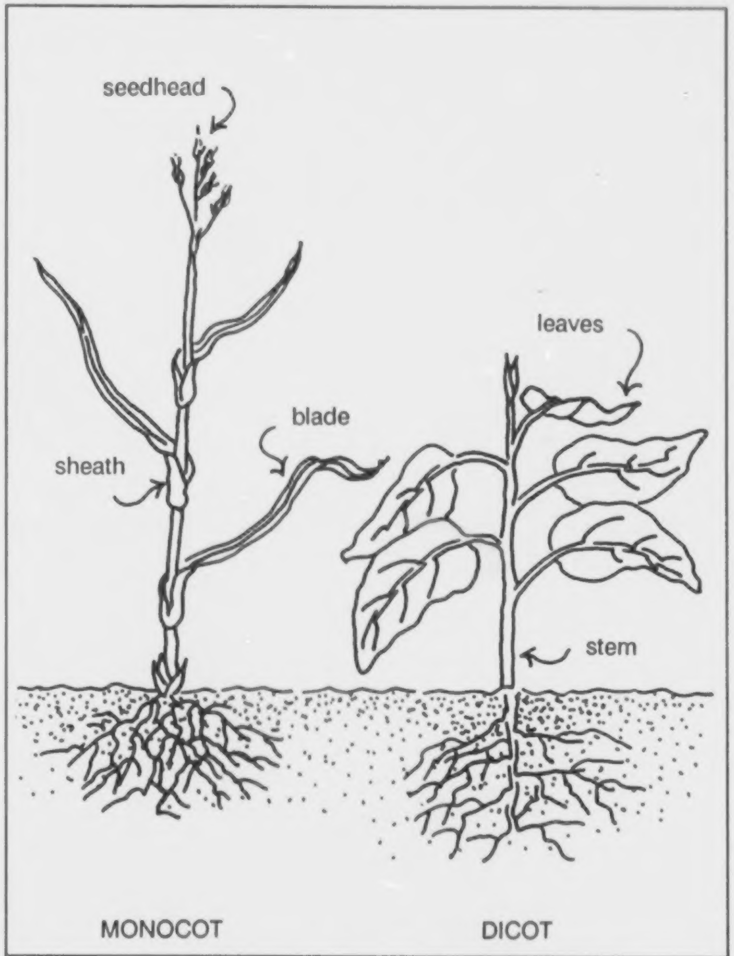
Monocot plants - The external structure of a monocot distinguishes it from a dicot. Monocot plants have only one seed leaf (cotyledon). The leaves are usually narrow, with parallel veins; flower petals occur in threes or sets of three. The monocots discussed here are grasses. Examples of other monocots are corn, lilies, iris, bamboo, orchids, and palm trees.

Monocots also have a unique internal structure. Monocot stems (Figure 1.2) have vascular bundles randomly scattered throughout the plant stem. Each of these small bundles contain phloem (where manufactured food is transported) and xylem (where absorbed water is transported). Monocot stems have no cambium.

Dicot plants - The external structure of dicot plants differs from that of a monocot plant. Dicot plants have two seed leaves (cotyledons). The leaves can vary in shape, and usually have netted venation. Their flower petals occur in groups of four or five.

The internal structure of dicots sets them apart from monocots. Dicot stems (Figure 1.3) have vascular bundles arranged in a cylindrical form. The bundles contain phloem and xylem cells separated by the vascular cambium, which is the area of new cell production. Phloem cells are produced toward the outside, making up the bark of the tree. Xylem cells are produced toward the inside of the stem.

Figure 1.1 - Monocot and Dicot Plants



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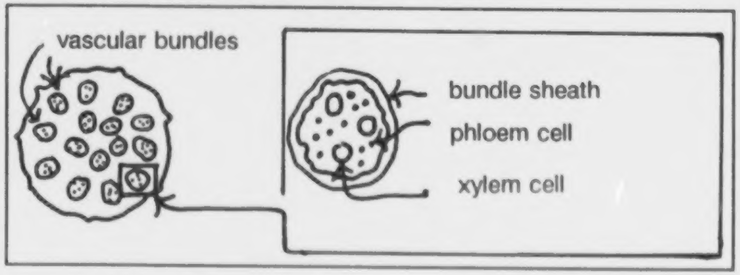
Growth in Diameter

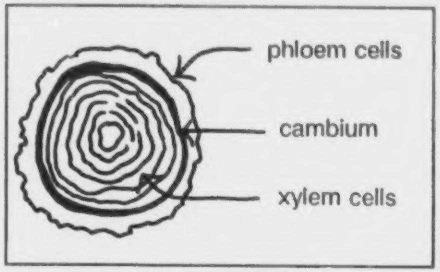
Since monocot plants have no cambium, the plants increase in diameter by expansion of the cells developed initially, rather than by the formation of new cells. See Figure 1.2.

Figure 1.2 - Cross Section of Monocot Stem


vascular bundles
bundle sheath
phloem cell
xylem cell

Dicot plants, on the other hand, have a cambium in which new xylem and phloem cells are produced. The xylem cells build up year after year, which causes the tree to expand in diameter. Phloem cells do not build up. See Figure 1.3.

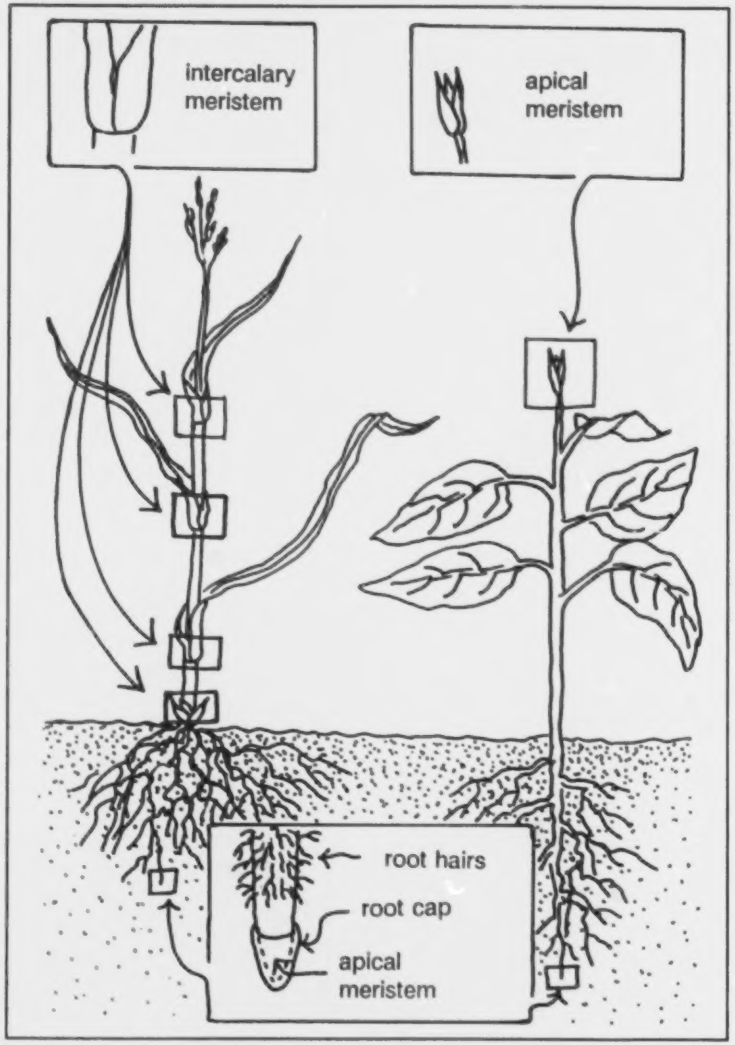
Figure 1.3 - Cross Section of Dicot Stem


phloem cells
cambium
xylem cells

Meristems and Plant Growth

In a plant, the tissue where active cell division occurs is called the meristem. Apical meristems are found in the tips of plant roots and stems. See Figure 1.4. Cell division here causes the roots and stems to grow in length and height respectively. Unlike dicot plants, grasses do not have their growing point at the tip of the stem. Instead, they lengthen by increasing cell division at the intercalary meristem. This

Figure 1.4 - Plant Growth Points


intercalary meristem
apical meristem
root hairs
root cap
apical meristem

area is found just above the node, at the lower part of the plant stem. For this reason, grass is a good choice for lawn material since it can be mowed without removing the growing point.

Summary

Differences in the growth habits of monocot and dicot plants allow them to serve different purposes in the landscape. Differences such as the location of the meristem, dictate important landscape maintenance procedures such as pruning. Knowing the type of growth to expect from a plant helps a landscaper to effectively select and place a plant in the environment.

Credits

Baudendistal, Robert F. Horticulture: A Basic Awareness. Reston, VA: Reston Publishing Co., 1979.

Bienz, D.R. The Why and How of Home Horticulture. San Francisco: W.H. Freeman and Co., 1980.

Dean, H.L. Biology of Plants: Laboratory Exercises. 4th ed. Dubuque, IA: Wm. C. Brown Company., 1978.

Reiley, H. Edward; Shry, Carroll L., Jr. Introductory Horticulture. 3rd ed. Albany, NY: Delmar Publishers, Inc., 1988.

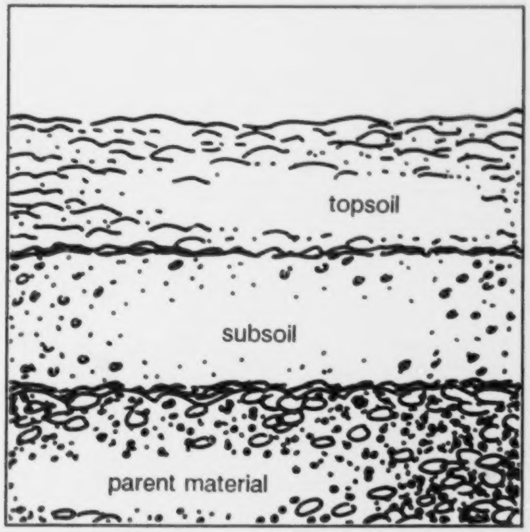
Since soil is a very important component in making a healthy landscape, it is one that should not be overlooked. Soil provides water, nutrients, and anchorage to plant roots.

Components of Soil

In a cross-sectional view of the earth's crust or soil profile, the bedrock, subsoil, and topsoil can be seen. See Figure 2.1. Soil is the result of many years of weathering of the bedrock. Weathering may occur by wind, freezing and thawing of the soil, water movement, plant roots, and microbial activity breaking down the bedrock.

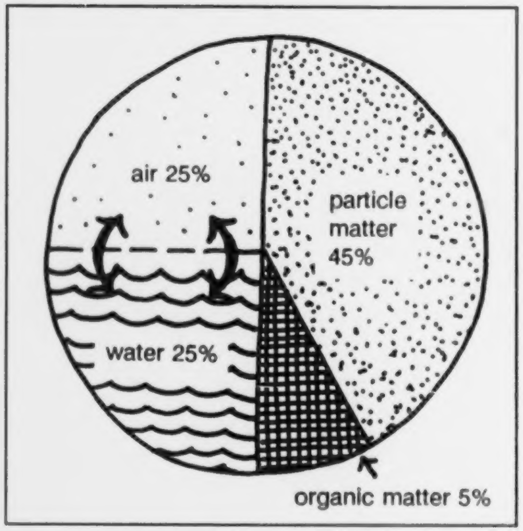
An ideal soil contains 45% particle matter, 5% organic matter, 25% water, 25% air, and microorganisms to break down organic matter. See Figure 2.2.

Figure 2.1 - Cross-Section of Earth's Crust



Soil types - Types of soils vary depending on the amounts of the ideal components they contain. Some soils are hard with little organic matter. Some are high in organic matter and easy to work. Some are rocky and some fine. These differences occur because of the way soils are weathered, the climate, and the way they are transported. The soils best suited for agricultural use are alluvial soil and glacial till. Alluvial soils are moved by water and deposited in plains (the Midwest) and deltas. Glacial till is transported by glacier movement. Loess is soil moved by the wind.

Figure 2.2 - Soil Components



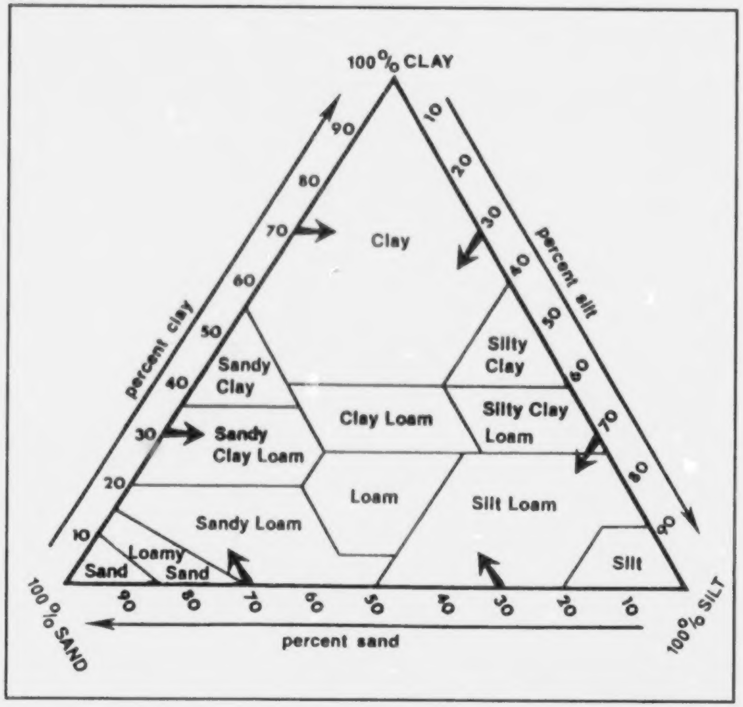
Environmental Factors Affecting Plant Growth

When bedrock weathers, it forms particles of different sizes. These particles make up the soil texture. The arrangement of these particles make up the soil structure. The quality of the soil structure determines how air and water move through the soil. PH and fertility of a soil depend on the type of particle or mineral matter in the soil as a result of the weathering process. These six environmental factors in the soil; texture, structure, air, water, pH and fertility; play a major role in the growth of a plant. Knowing how these factors in the soil affect plant growth can mean the difference between a live or dead plant.

Soil Structure and Texture

Textural triangle - Soils are made up of different sized particles. These particles are called soil separates and include gravel, sand, silt, and clay. The proportion of these separates in the soil determines the soil texture. Most soils contain sand, silt, and clay. The amounts of each of these separates found in the soil determines the soil name. See the textural triangle illustrated in Figure 2.3. To use the triangle, use any two of the percentages for a soil and project them into the triangle following the direction indicated by the arrows and the grid lines. Within the compartment where the two lines intersect, the textural name of the soil is read. Loam soils are best for agricultural use.

Figure 2.3 - Textural Triangle



Sand - Sand particles provide drainage in the soil. They allow much air space between the particles to allow water to pass through. Sand does not offer many nutrients to the plant and is not chemically active.

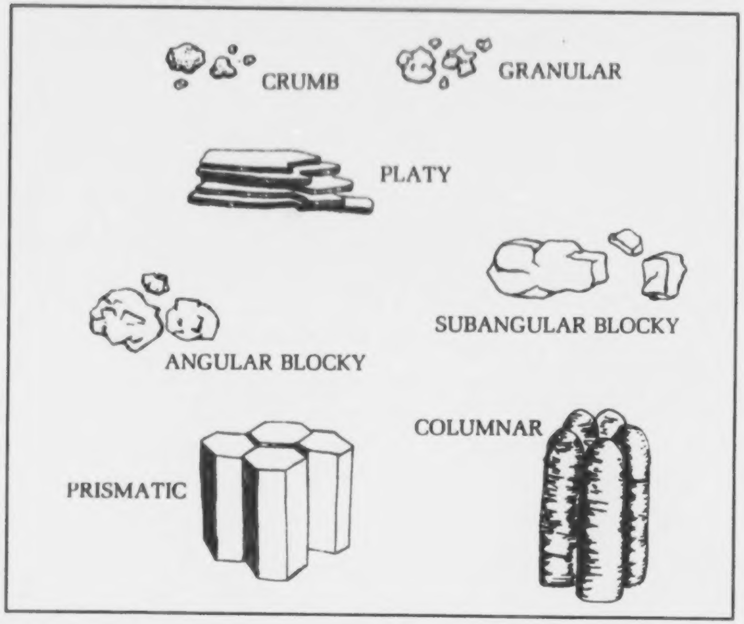
Silt - Silt particles are much smaller than sand, giving silt a larger surface area. Water holds onto the surface of particles. With a greater surface area, more water can be held by silt than sand. Like sand, silt does not offer many nutrients and is not chemically active. The pore space around silt is less than that of sand.

Clay - Clay particles are smaller than silt particles, offering even more surface area. Therefore, clay holds more water than silt. Since the particles are much smaller, the air spaces around them are very small; therefore, water passes through a clay soil very slowly. Clay offers many nutrients to plants and is also very chemically active. A heavy clay soil has very poor drainage which can cause problems in plant growth.

Soil structure - The pore space sizes in a soil determine the amount of water, air, and root penetration that can move through the soil. The pore space is determined not by the individual particle sizes but by the size of the particles joined together. Particles grouped together form aggregates. The arrangement of these aggregates make up the soil structure. Aggregate structure forms are based on shapes including; flat or slate, prism-like, block-like, and granular. See Figure 2.4. The granular structure has many pore spaces which makes it best for horticultural use. The structure of a soil is best improved by adding organic matter. This helps to stabilize the granular aggregates. Organic matter comes from decomposing plant tissue. The decomposing plant material and clay, together form the granular aggregate. Therefore, the more organic material available, the better the soil structure. Building a good soil structure can take years. Destroying it can be done quickly by tilling or compacting soil when it is too wet. This breaks up the aggregate and allows for a more dense pack of soil particles. Eventually it will prevent water, air, and roots from moving through the soil.

A soil with a good balance of sand, silt, and clay (a loam soil); along with adequate organic matter to provide pore spaces for air, water, and roots is a good environment for root growth. Once a sturdy root system is established, maintaining a plant becomes much easier.

Figure 2.4 - Aggregate Structure Forms



Soil color - The color of the soil can tell a landscaper a lot about the history and properties of the soil.

1. A dark soil is usually one high in organic matter and nutrient content.
2. A uniformly colored soil is usually a young soil, uniform in soil properties, and has undergone little weathering. It is good for root growth.
3. A yellowish or reddish colored subsoil is usually older, lower in nutrients, and has poor structure. It usually does not allow much root penetration.
4. A whitish colored soil is usually high in lime which can cause some nutrient deficiencies for certain plants.
5. A bluish or grayish colored soil is usually poorly drained and has poor aeration.

Soil depth - The depth of a soil influences the depth roots will grow. It also determines the amount of moisture and nutrients that are in the soil. The deeper the soil, the more water and nutrients are available to the plant roots. A deep soil also allows roots to grow deeper for an abundant root system. In landscaping, the depth of a soil can be increased by using raised beds or mounds.

Air and Water

Balance - When a soil balance of 25% water and 25% air is maintained, plants will react favorably. If the soil is extremely high in air (less water) or high in water (less air), the plant will suffer. The two components cannot occupy the same space at the same time. As the pores fill up with water, air is pushed out.

A soil too high in water content will cause the roots to suffocate and rot. Water logged soils are anaerobic (lack of oxygen) and have a distinctly swampy smell. If the roots rot, water cannot be taken up for the plant; therefore, it wilts and dies. If the air content is too high, water is being restricted from the plant. This also causes the plant to wilt and die.

Pore spaces - Air is essential for growth of healthy roots. Pore spaces are the portion of the soil volume that does not have solid particles. Porosity is determined by texture and structure. Sands have more continuous and larger pore spaces that allow water to flow through readily, whereas clay soils have many small pore spaces that cause water to move through slowly. In loam soils, there are small pore spaces supplied by clay that retain water and larger pore spaces provided by sand that allow for drainage and aeration. This is another factor that makes loam soils good for horticultural use.

Water - The amount of water a soil can hold is determined by the size and number of pore spaces. Think of the soil as being like a sponge. A sponge, like the soil, has many pores; some are large and some are small. The large pores make up 30-50% of the total pores. These are called non-capillary pores. Non-capillary pores are large enough to allow water to drain freely from them. See Figure 2.5. If a sponge is soaked in a bucket of water and held up, water will drain freely from the non-capillary pores. Prior to draining, the sponge is said to be "saturated." Water added to a saturated soil will "runoff" the surface on slopes or cause puddles in low areas. Water pulled away from the sponge by gravity is called gravitational water. When the gravitational water stops freely dripping, the sponge is at "field capacity." Field capacity is the state at which the soil holds the maximum amount of water without further downward drainage. Water is then held by the smaller pores against the pull of gravity by capillarity. Therefore, it is called capillary water. One-half of the capillary water in the soil is available to plant roots for water uptake. This is called available water.

When the sponge is squeezed, the available water drips from the sponge leaving a sponge that is still damp. The water left in the sponge is held so tightly by tiny pores that it can not be squeezed out. This is called hygroscopic water. In the soil, the hygroscopic water adheres to soil particles so tightly that it is not available to plant roots. When a plant has absorbed all of the available water that it is able to get from the soil, it has reached the permanent wilting point. The plant will not revive unless water is added to the soil.

Inhibition of water movement - Water movement can be inhibited by compaction, ruining the soil structure, and also by layering of different textured soils. If a coarse-textured soil is located below a fine-textured soil a perched water table will result. This means the water will not move into the lower (coarser) texture, where many roots are located, until the upper (finer) texture is saturated. Therefore, the roots below the perched water table may die and the roots above may rot. This happens in landscaping when gravel is placed in the bottom of the planting hole supposedly to improve drainage.

Fertility and pH

Fertility - Fertility is determined by the ability of soil surface particles to absorb nutrients. Nutrients are supplied in the form of mineral salts and are added to the soil when rocks weather, organic matter is supplied, or fertilizer is added. When these salts are dissolved into solution by water (soil solution), ions are present.

Soil solutions - Roots are only able to absorb nutrients in their ion state. Most nutrients needed for plant growth are found in the clay and organic matter particles in the soil. Because of their small size, they are able to remain suspended in soil solution. Clay and organic matter are colloidal particles because their surfaces hold positive or negative charges and attract water and ions. Positively charged ions are called cations; negatively charged ions are called anions.

Cation Exchange Capacity (CEC) - The ability of soil, which is negatively charged, to attract positively charged cations and exchange one for the other is called "Cation Exchange Capacity" (CEC). The greater the number of particles of clay and organic matter found in the soil, the higher the CEC. Nutrients would easily be leached from the soil without the CEC. A soil test with a high CEC indicates a greater capacity to store nutrients.

Soluble salts testing - Soils can be tested for the amount of soluble salts they contain. An instrument called a solu-bridge is used for this purpose. If a solu-bridge is not available, a soil sample can be sent to the county extension agent for testing. The readings can be between 0.1 and 3.51 or above. The best range for plants is 1.0 - 1.50. If too low, the plants may be nutritionally starved. If too high, plants may appear wilted and nutritionally deficient.

Soil pH - pH (potential hydrogen) refers to the soil reaction between hydrogen ions (H^+) and hydroxyl ions (OH^+) in the soil. A soil higher in hydroxyl ions is an alkaline, or basic, soil. A soil higher in hydrogen ions is an acidic soil. A soil equal in hydrogen and hydroxyl ions is neutral. The pH scale runs from 0-14. Zero equals a very acidic soil, 14.0 equals a very alkaline soil, and 7.0 is neutral. Most plants prefer a neutral pH of 6.5 to 7.5. Acidic soils with a pH between 0 and 7 are called sour soils. Alkaline soils with a pH between 7 and 14 are called sweet soils. Soils that receive heavy rainfall or are in very humid areas tend to have the basic ions leached out leaving an acidic soil. Areas that have little or no rainfall tend to have alkaline soils because the basic ions are not leached out as much. These are usually arid regions.

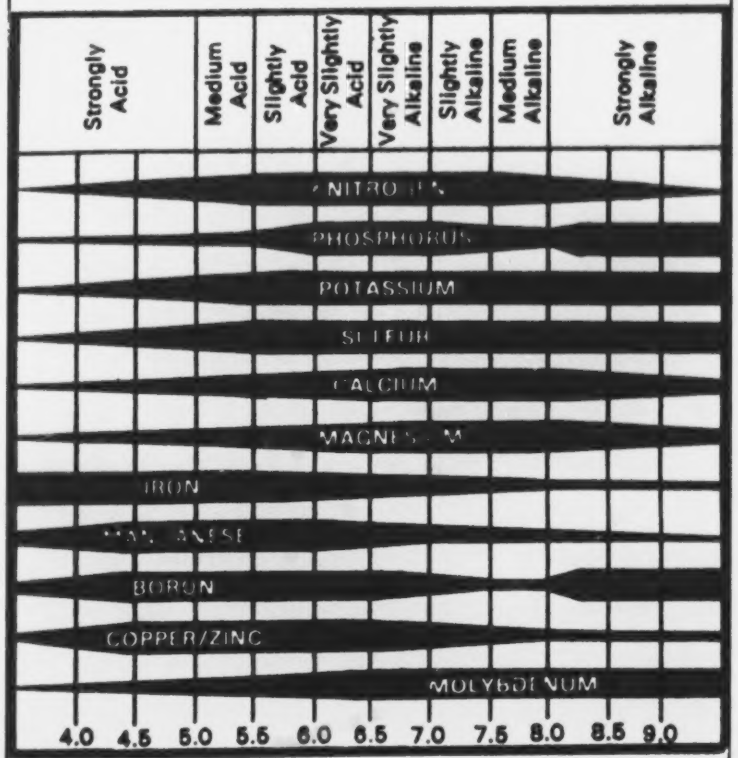
Effects of soil pH - Plant growth is affected by pH in an indirect way. It affects the availability of nutrients to the plant roots. If a soil is acidic, some nutrients like phosphorus are tied up and cannot be used by the plant. The same is true with an alkaline soil. If it is too alkaline, other nutrients such as iron are tied up. No matter how good the fertility of a soil is, without the proper pH, nutrients will be either toxic (excessive availability) to the plant or not available (tied up) for root absorption. See Figure 2.5. Most nutrients are available at pH levels that are close to neutral. Acidic soils have high or toxic concentrations of manganese and aluminum. Acidic soils also have reduced numbers of beneficial microorganisms that decompose organic matter. Alkaline soils reduce the solubility of all micronutrients. When the pH is 8.5 or above, the soil has a high concentration of sodium which causes reduced growth or death of a plant.

Adjusting pH - The pH of a soil can easily be determined by a pH meter or the soil sample can be sent to the county extension agent for testing. If a soil is too acidic, lime or agricultural lime will help raise the pH. If a soil is too alkaline, sulphur or aluminum sulphate will help lower the pH. Most landscape plants prefer a pH of around 6.0, slightly acidic. Check the pH preferences of specific plants in the landscape.

Improving the Soil

Organic matter - Adding organic matter is the most beneficial way to improve the soil. Organic matter is any plant or animal residue or remains. It helps improve the soil texture and structure by increasing the pore spaces which will increase permeability (allow more water and air to pass through the soil). If a soil remains too wet, drainage tiles may be placed underground to drain off excess water. If the soil is too dry for plant growth, an irrigation system should be used. Or if the soil does not hold much water (a sandy soil) organic matter and clay may be added to increase water retention. Decomposing organic matter

Figure 2.5 - Nutrient Availability



Soil pH Governs Nutrient Release

Acidity or alkalinity (pH) controls relative nutrient availability.

also adds to the soil fertility. The best types of organic matter to use to improve the soil are peat moss, bark, decomposed sawdust, manure, compost, and rice hulls. Straw or fresh wood products are not good sources of organic matter for soil improvement. When sawdust and certain barks are used, they must first be leached to remove any phytotoxic chemicals that would harm plants. These materials must make up 25-40% of the soil in order to improve it. When cultivating to a depth of eight inches, add three to four inches of organic matter on the top and mix in. Nitrogen should also be added along with organic matter. The production of microorganisms is increased when organic matter is added. Microorganisms use nitrogen. If the nitrogen level is low, microorganisms will use what is available, leaving an insufficient amount for plant growth.

Tilth, which refers to the physical condition of the soil, can also be improved by adding organic matter. This separates the soil particles, allowing more air and water in the soil.

Tilling - Tilling can improve the tilth of a soil. Coarse-textured soils allow plenty of air to the roots but do not hold much water. Tilling can break up the soil to make it finer and able to hold more water. Fine-textured soils hold plenty of water and nutrients but do not allow enough air to pass through the soil. Tilling can aerate the soil. Tilling will also break up a hard soil surface to prevent water run off and erosion and allow the water to soak into the soil.

Conclusion

Having a successful landscape depends on the soil. The texture, structure, air, water, fertility, and pH are all important in the the success of a plant. Time must be taken to properly evaluate the type of soil at a site and to make any changes to improve the soil, if needed. It is important not to get in a hurry and just "stick" a plant in the ground. The plant might make it in a poor soil, but it will look mediocre. Why settle for mediocre when, with a little more time and energy, one can have a healthy plant?

Credits

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The environment above ground, climate, is just as or even more important than the underground environment. Although landscapers may not be able to do anything about the climate, they must understand it and how it affects plants in order to choose the plant material that is best suited for an area. The climate determines the cultivation practices that must be used for a plant or landscape. Climate is determined by the light intensity, precipitation, temperature, humidity, air quality, and wind.

Climate types

A macroclimate is the climate in a large area such as the midwest. It is influenced by mountains, forests, oceans, air masses, elevation, and seasons. A mesoclimate is on a smaller scale, such as a city or a large farm. It is influenced by buildings, lakes, and topography. A microclimate is on an even smaller scale, such as a yard, an individual plant, or a group of plants. A particular microclimate is influenced by a house, slopes, hills, and awnings. For example, a house may have different temperatures or light intensity around it, depending on the orientation to the sun. A south-facing slope in the yard will be warmer than a north-facing slope. This will help in determining what plant material to use. The north side of a house is cooler than the south side. A house may block northerly winds from sensitive plants. A microclimate may be modified to suit a landscape plan.

Temperature

Temperature has one of the strongest effects on how well plants grow. It interrelates with photosynthesis, transpiration, and respiration.

High temperatures - If the temperature is too high (around 96° F; 36°C), photosynthesis can not keep up with respiration, and the plant stops growing. These temperatures vary from plant to plant. Temperature also determines what pests and diseases will be most active. Higher temperatures usually result in more pests and disease. Pathogens multiply more rapidly. Also, during mild winters, insects are not killed, and a large insect population is left.

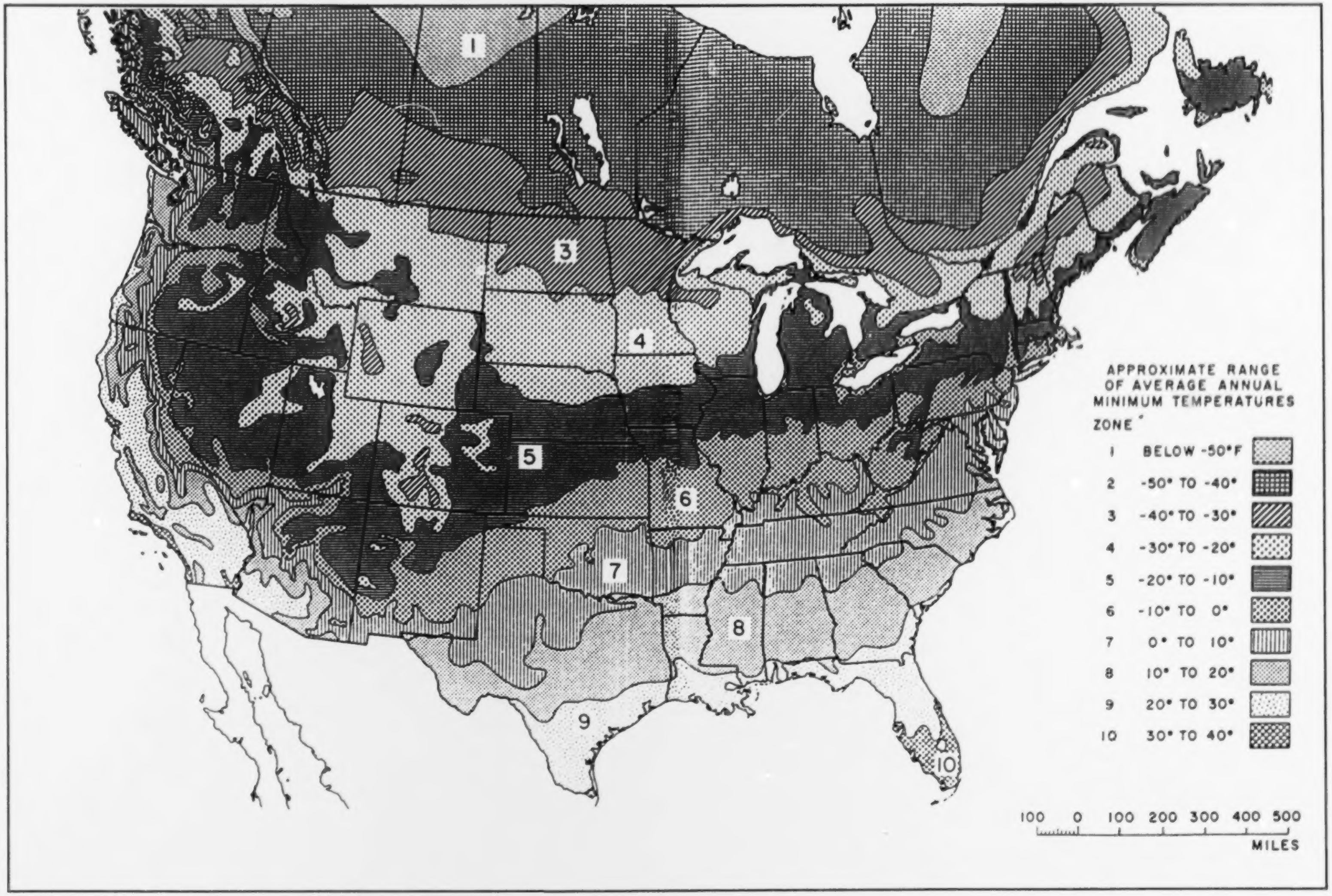
Hardiness zone - When temperatures are too low, plant processes slow down. Temperatures that are too cold to plants are usually of greater concern to landscapers than temperatures that are too hot. For each plant there is a temperature below which the plant will receive damage. The USDA hardiness zone map in Figure 3.1 tells the average minimum temperature of the area or zone. It is divided into ten zones with ten degree increments. Most of Missouri is in zone six, although the northern part of the state is in zone five, and the boot heel area is in zone seven.

Woody plants are divided into categories based on the minimum temperature in which they are likely to survive. To determine if a plant will survive in a particular area, find the zone of the area, then look at the zone listed for the plant. The map is a rough guide; there are times and exceptional conditions that will not be favorable to a plant that is supposed to grow in that zone. Past experiences of landscapers will help to predict whether a plant will survive in a particular area. A plant may grow in a warmer zone than listed, but not in a colder zone.

Low temperatures - Plants can be damaged in several ways if the winter temperature drops too low. The plant can suffer from freeze damage. This occurs when the low temperatures freeze the water in the plant, causing the cells to burst. The tissues involved may wilt and die. This usually happens on still, cloudless nights. A late spring frost can damage young, tender growth or newly-formed flower buds. This can be costly in fruit production. The roots or bark of a tree can be damaged if the tree goes into winter with very little moisture around the roots. Plants can also be damaged by heaving. Heaving is the result of repeated freezing and thawing of the ground. As this happens, the rootball is heaved out of the ground. Also, the weight of snow or ice can break tree branches.

Warm- and cool-season crops - Plants are classified as warm-season and cool-season crops. Cool-season crops thrive in cooler temperatures of around 60° - 80° F. Cabbage, dahlia, apple, azalea, and rhododendron are examples of these. Warm-season crops grow best in temperatures of around 75° - 90° F. Some examples are

Figure 3.1 - Hardiness Zones


1
3
4
5
6
7
8
9
10
APPROXIMATE RANGE OF AVERAGE ANNUAL MINIMUM TEMPERATURES
ZONE
1 BELOW -50°F
2 -50° TO -40°
3 -40° TO -30°
4 -30° TO -20°
5 -20° TO -10°
6 -10° TO 0°
7 0° TO 10°
8 10° TO 20°
9 20° TO 30°
10 30° TO 40°
100 0 100 200 300 400 500
MILES

melons, tomatoes, marigolds, and petunias.

Rest period - Certain plants, such as apples and peaches, need a rest period when temperatures are cool. If this rest period does not occur, the plant may not grow the following season. The rest period is a phase during which a plant is physiologically unable to initiate growth, even though environmental conditions may be favorable. This differs from dormancy in that dormant plants will continue to grow as soon as environmental conditions become favorable.

Light

Light is necessary for a plant to carry out photosynthesis or manufacture food.

Wavelength - Light is composed of different wavelengths that the eye sees as color. These are violet, blue, green, yellow, orange, red, and infrared. Many of the blues, ultraviolet rays, and red rays are filtered out by dust particles and gases in the air. The ultraviolet and red rays are important for anthocyanin formation. Anthocyanin is a pigment that gives many plants and plant products, such as apples, their red color. This is why apples produced in the dry, mountain air of Washington valleys are redder than Missouri apples. Plants use mostly the blue and red rays of the color spectrum for photosynthesis.

Intensity - Some plants require a higher or lower intensity of light to thrive. Light intensity affects the height of a plant, the length of internodes and the color of leaves. Too much low-intensity light leads to a tall, spindly plant (long internodes) and pale-colored leaves. Too much light leads to very compact growth with pale, washed-out or burned leaves. In shrubs, growth can be so dense that the leaves on the inside of the canopy will not survive. Pruning can help open up the shrub to let in light.

Responses to light - Light triggers different responses in plants, including phototropism and photoperiodism.

Phototropism - Light can cause plants to grow in the direction of the most light intensity. This is called phototropism. An example is the sunflower plant. In the morning the face of the sunflower is turned east, where the sun rises; and in the evening it is facing west, where the sun sets.

Photoperiodism - Photoperiodism is the response plants have to a particular day length. Temperature plays a role in the response plants have to day length. The response to day length may be increased by warm weather or slowed by cold weather. Photoperiodism can affect flowering or reproduction, and determine leaf shape, the onset of dormancy, and fall color. The intensity of light that triggers a photoperiodic response is much less than that needed for photosynthesis. Therefore, a street light may affect photoperiodic responses, while not initiating photosynthesis.

Long-day plants - Long-day plants will bloom only if they receive more than a certain number of hours of light. On short days, they remain in the vegetative phase of growth and they will not bloom, indicating reproductive stage, until the days are long. Some examples of long-day plants are spinach, onion, Easter Lily, and Rose-of-Sharon (Hibiscus Syriacus). Usually a long-day plant needs around sixteen hours of light each day in order to bloom, but the actual hours needed depend on the individual plant.

Short-day plants - Short-day plants will bloom only if they receive fewer than a certain number of hours of light. On long days, they will remain vegetative until they receive enough short days to bloom. Some examples of short-day plants are chrysanthemums, poinsettia, and Christmas cactus. A short-day plant needs around sixteen hours of darkness per day to bloom but the hours needed are different for each individual plant.

Day-neutral plants - A plant that does not respond to day length is called day-neutral. Examples of day-neutral plants are African violet, tomatoes, and roses.

Water

Water is the most limiting factor in plant growth. It is also a nutrient used in photosynthesis.

Water status - When a plant is turgid, its parts are fully extended as a result of the cells being filled with water. A plant is wilted when the cells are not filled with water; therefore, the parts are limp and hang down. Water enables a plant to regulate its temperature by transpiration, which allows water to evaporate from small pores in the leaf. As the water evaporates, the temperature drops. Temporary wilting occurs when the plant is transpiring faster than the roots can take up water, as on hot summer days when a strong wind is blowing. The plant usually recovers at night.

Deficiency - When a plant is deficient in water the leaves turn a gray-green color, roll at the edges, wilt, and if severe, drop off. When vegetables are deficient in water, the quality is lowered. They can taste bitter or hard. Fruit grown with a water deficiency tastes woody. Also, flower buds drop early when a plant is water-deficient, causing lack of fruit production.

Drought can cause serious damage to plants. In areas where it only rains once every four months, the plants that survive are adapted to the amount of water available. However, in areas where it normally rains once every one or two weeks, a drought of five weeks can be detrimental. The plants will be smaller than usual, but the root systems will be quite extensive.

Excess - As discussed in the previous lesson, plants that receive excess moisture will suffer as much as those without enough. The plant roots will suffocate and die. The plant leaves yellow, wilt, and even die. Excess water also causes problems of disease. Soil-borne disease organisms grow rapidly and become active with excess water. An example is damping-off disease, which causes death of the stem at the soil level. The stem is eaten by soil organisms. Foliar (leaf) diseases also increase in times of heavy rainfall or humidity. Botrytis and powdery mildew are two examples of foliar diseases.

Fruit high in sugar can suffer from excess moisture at or right before harvest. A rain at this time may cause the skins of fruit such as cherries and tomatoes to split. Excess absorption of water causes the cells to split.

Humidity - Humidity is the level of moisture in the air. "Relative humidity is the amount of moisture in the air as compared to the percentage of moisture that the air could hold at the same temperature if the air were completely saturated" (Reiley, Shry, 1988). Forty to eighty percent relative humidity is best for plants. Relative humidity does not affect most plants, except for more sensitive ones. Low relative humidity does not usually hurt plants unless the wind is blowing strongly, which can cause transpiration to occur more rapidly than the roots can absorb water.

Air

Wind - As mentioned previously, wind increases the rate of transpiration. More water passes through the leaf surface when the wind is blowing. If a leaf loses more moisture than is replaced by the roots, desiccation occurs, which causes death of the leaf or branch tissue. If the plant is by itself or there is open canopy, the rate of transpiration will be higher than if the plant is in a grove or tree canopy is dense. The rate is even faster and more damaging if the air temperature is high and the relative humidity is low. Heavy winds can cause breaking and tearing damage to plant leaves, branches, and trunks. Tornadoes can uproot even the largest trees. Since photosynthesis requires CO_2, more CO_2 is available to the leaves when the wind is blowing, especially those in a dense tree canopy. Wind also increases the effects of cold temperatures. Table 3.1 shows these effects.

Air pollution - Air pollution can cause problems in a landscape, especially those in big cities or industrial areas. Plants are damaged by the stomata being clogged and the leaf surface being covered with dust, thus decreasing the amount of available sunlight, which slows photosynthesis. The leaves may drop, and branches or the whole tree may die.

TABLE 3.1 - Wind Chill Factors

Wind Speed (Miles per hour)	Equivalent Temperature (°F)																
Calm	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	32	27	22	16	11	6	0	-5	-10	-15	-21	-26	-31	-36	-42	-47	-52
10	22	16	10	3	-3	-9	-15	-22	-27	-34	-40	-46	-52	-58	-64	-71	-77
15	16	9	2	-5	-11	-18	-25	-31	-38	-45	-51	-58	-65	-72	-78	-85	-92
20	12	4	-3	-10	-17	-24	-31	-39	-46	-53	-60	-67	-74	-80	-88	-95	-103
25	8	1	-7	-15	-22	-29	-36	-44	-51	-59	-66	-74	-81	-88	-96	-103	-110
30	6	-2	-10	-18	-25	-33	-41	-49	-56	-64	-71	-79	-86	-93	-101	-109	-116
35	4	-4	-12	-20	-27	-35	-43	-52	-58	-67	-74	-82	-89	-97	-105	-113	-120
40	3	-5	-13	-21	-29	-37	-45	-53	-60	-69	-76	-84	-92	-100	-107	-115	-123
45	2	-6	-14	-22	-30	-38	-46	-54	-62	-70	-78	-85	-93	-102	-109	-117	-125

*"Calm-air" as used in wind-chill determinations actually refers to the conditions created by a person walking briskly (at 4 miles-per-hour) under calm wind conditions.

Courtesy of the U. S. Department of Commerce. National Oceanic and Atmospheric Administration, National Weather Service.

Sulphur dioxide, fluoride, ozone, and PAN (peroxyacetyl nitrates) are the main causes of damage. Sulphur dioxide is produced by the burning of coal and smelting ores. Fluoride is produced by the heating of steel and aluminum. "Ozone and PAN are oxidants formed in the atmosphere by a photochemical reaction between hydrocarbons and nitrogen oxides in the presence of sunlight" (Harris 1983). These occur from the combustion of coal and petroleum vehicular exhaust. Although carbon monoxide has not been found to damage plants; oil, rubber, lead, and soil can be deposited on leaves in high traffic areas. Although manufactured pollutants in the air cause damage; natural polluters, such as volcanoes, can create six times the amount of pollution as human activity.

Symptoms of pollutant damage - Sulphur dioxide causes dead spots the upper sides of the leaves of dicot plants. In monocot plants, the dead spots are streaked between the veins on the upper sides of the leaves. The dead areas become tan-colored and have a papery texture. Fluoride injury causes death of the tips and edges of leaves on both monocots and dicots.

Ozone injury shows up as speckling or stippling on the upper side of the leaf. PAN or smog injury causes a glazed or bronzed band across the under-surface of the leaves. This band is in different locations depending on the maturity of the leaf. It is found at the tip of young leaves (since the apex matures first), the middle of nearly-mature leaves, and at the base of mature leaves (since the base matures last). These banded areas stop growing. Therefore, the leaf may look pinched. Prolonged exposure can result in death of the leaf.

These symptoms are sometimes difficult to distinguish from other problems. The length of exposure and the concentration of the pollutant determine the amount of damage. Some plants are more sensitive and some more tolerant. The best solution is to decrease the amount of pollution produced everywhere. Since this solution will take nation-wide effort and a long time, planting pollution-tolerant trees is an effective step toward solution to take now. See Table 3.2 for a list of trees that are tolerant to air pollution and city conditions. Also, hose down plants periodically or if they are oily, use a detergent solution to remove the build-up on the leaves. Some fungicides such as benomyl and some growth retardants such as B-9 have been used to increase tolerance. This only protects the growth after treatment.

Summary

Mean temperature, hardiness zone, record temperatures, precipitation records, humidity levels, light intensity, wind intensity, and air quality affect the selection of plants that will grow in a particular area. Planting dates can be set by using the last spring and first fall killing frost dates as guidelines. In Missouri, for example, according to Bienz (1980), the last spring killing frost is April 10 and the first fall killing frost is October 31.

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TABLE 3.2 - Trees that Tolerate City Conditions

Botanical name	Common name	Zone
Acer species	Maple	3-9*
Aesculus carnea	Red horsechestnut	4-8
Carpinus betulus	European hornbeam	4-9
Casuarina cunninghamiana	Beefwood	6-7
Catalpa species	Catalpa	5-10
Celtis occidentalis	Common hackberry	5-8
Chionanthus virginicus	Fringe tree	5-8
Cotinus coggygria	Smoke tree	5-9
Crataegus species	Hawthorn	4-9*
Fraxinus species	Ash	3-9*
Ginkgo biloba	Maidenhair tree	5-10
Gleditsia triacanthos inermis	Thornless common honeylocust	5-9
Ilex opaca	American holly	6-7
Koelreuteria paniculata	Goldenrain tree	5-9
Malus species	Crabapple	2-9*
Nyssa sylvatica	Black tupelo	5-9
Ostrya virginiana	American hop hornbeam	4-9
Phellodendron amurense	Amur oak	4-9
Pinus nigra	Austrian pine	4-8
Pinus sylvestris	Scotch pine	3-8
Pistacia chinensis	Chinese pistachio	6-10
Platanus acerifolia	London plane tree	5-9
Pyrus calleryana	Callery pear	5-9
Quercus species	Oak	4-9*
Robinia pseudoacacia	Black locust	4-9
Sophora japonica	Japanese pagoda tree	5-10
Tilia cordata	Littleleaf linden	4-9
Ulmus species	Elm	3-9*
Zelkova serrata	Sawleaf zelkova	5-9

*Varies with each species.

415

416

In order to make a landscape plan work, the right plant materials must be used on a site. It is essential that a landscaper know the available plant material and how to identify it. Each plant has unique characteristics that separate it from other plants. Plants are placed into categories according to similar habits of growth and physical features. The first step in plant identification is to know its category. The following terms describe some of the types of plants available.

Woody, Herbaceous, and Deciduous Plants; Evergreen Plants and Shrubs

Woody plants - Woody plants have an outer bark covering on older stems. They usually survive the winter and the stems increase in diameter.

Herbaceous plants - Herbaceous plants do not have a bark covering. Usually they are not able to survive a winter without protection. The stems do not increase much in diameter.

Deciduous plants - Deciduous plants are woody plants that drop their leaves and go into annual dormancy. They usually live several to many years.

Broad-leaf evergreens - Broad-leaf evergreens keep their leaves all year, dropping a few at a time to be replaced by new leaves. The tree is never bare.

Narrow-leaf evergreens - Narrow-leaf evergreens have needle-like leaves and are cone-bearing plants. Although they periodically drop needles which are replaced by new ones, the trees are never bare.

Shrubs - Shrubs usually have multiple, woody stems growing from the ground. They resemble trees, although they do not grow as tall. These can be deciduous, or broad-leaf or narrow-leaf evergreens.

Vines and Groundcovers

Vines - Vines can be woody or herbaceous, flowering or nonflowering. The stems are not sturdy enough to support the weight of the plant. They grow upright if they are able to attach to a trellis or wall; otherwise, they trail along the ground. Vines attach by tendrils or twining.

Groundcovers - Groundcovers can be woody or herbaceous, flowering or nonflowering, trailing or compact. These are low-growing plants used for ground cover. Groundcovers help prevent erosion.

Bedding Plants; Annuals and Perennials

Bedding plants - Bedding plants are used in flower beds and borders. They can be annuals or perennials, and are usually herbaceous.

Annuals - Annuals are herbaceous plants that have a lifespan of one growing season.

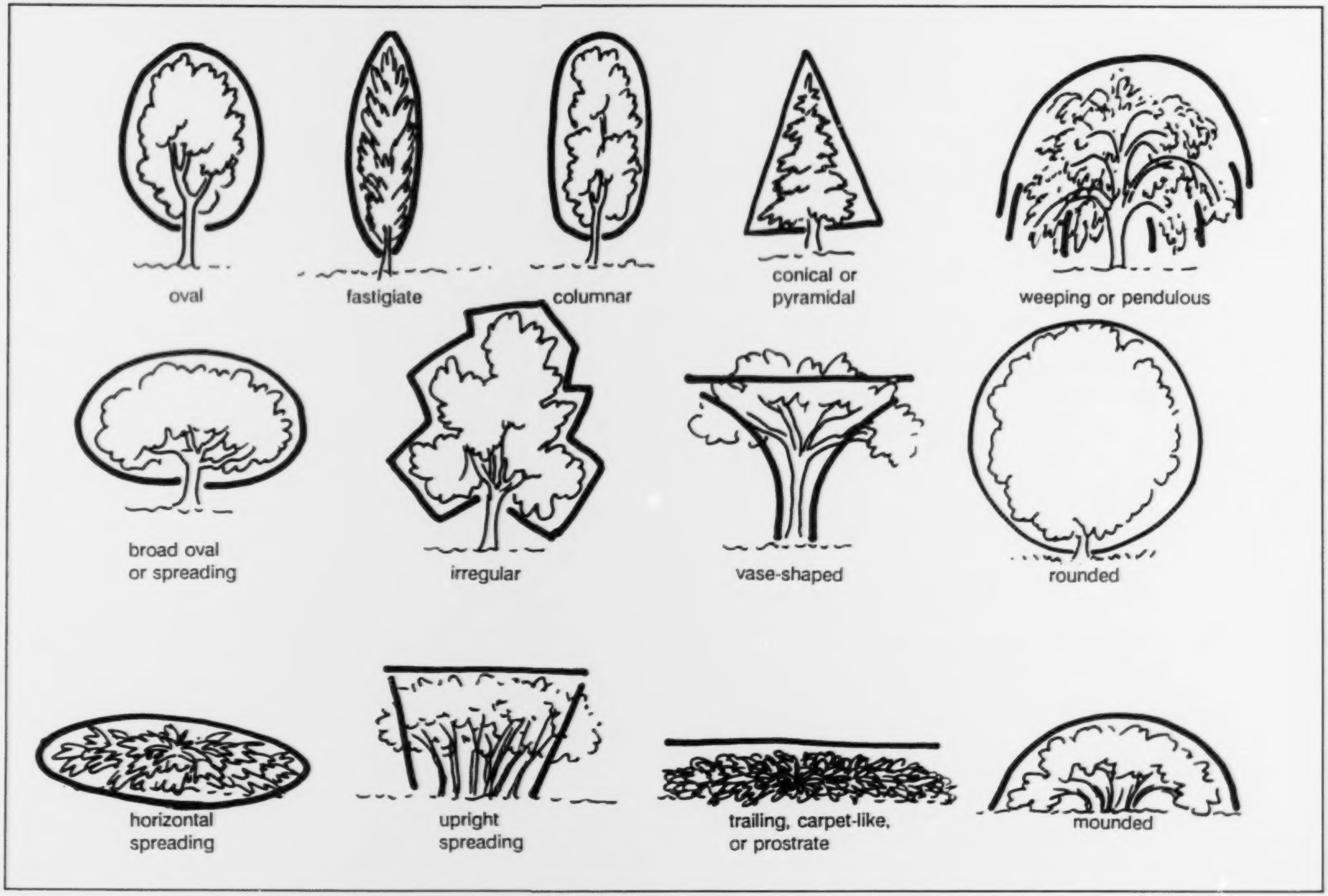
Perennials - Perennials are herbaceous plants that grow and bloom for many years. They may die in the winter, but will return every year.

Plant Form

External Features - Plants are identified by a number of external features. The form or shape, external stem structure, leaf structure and arrangement; all describe unique characteristics of plants that can be used in identification; just as height, weight, eye and hair color are used to identify people.

Form and branching habit - The form of a tree or shrub is the overall silhouette it develops at a mature age. The mature form should be the basis for selecting a tree or shrub but in-between shapes should also be considered. These in-between shapes may vary greatly from the

Figure 1.1 - Common Natural Tree and Shrub Forms

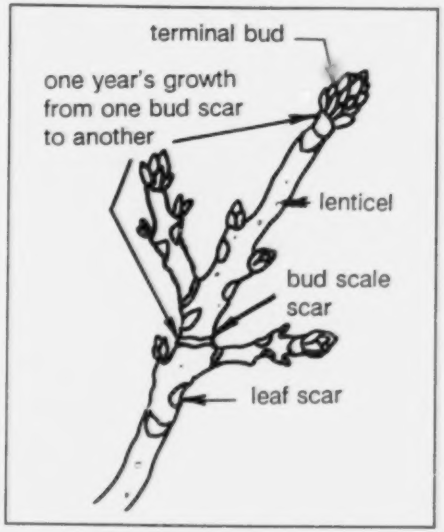

oval
fastigiate
columnar
conical or pyramidal
weeping or pendulous
broad oval or spreading
irregular
vase-shaped
rounded
horizontal spreading
upright spreading
trailing, carpet-like, or prostrate
mounded

mature form. The form is determined by its branching habit. Common natural tree and shrub forms are illustrated in Figure 1.1.

The growth habit of trees and shrubs help make up their overall form. For example; in some evergreens the branches overlay each other, giving a layered effect. This makes the tree look irregular in form.

Stem Structure

Figure 1.2 - Stem Structure

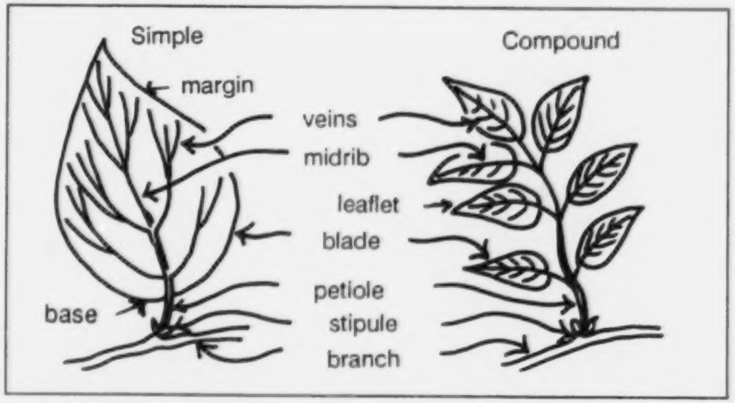


Trees can also be identified by the external structure of the stems. See Figure 1.2. A typical stem has a terminal bud and lateral buds. The terminal bud is the point where the new season's growth starts; this is usually larger than a lateral bud and is found at the stem tip. Terminal buds can also be flowering buds. Flowering buds can be distinguished by their large, round appearance. Axillary or lateral buds may be flowering (flat and large) or vegetative (thin and narrow). All buds grow out of nodes. The distance between nodes is the internode. A terminal bud scar is found where the previous year's terminal bud was located. The distance between two terminal bud scars shows one year's growth. Lenticels are breathing pores found scattered on the stem. A leaf scar is found where the leaf was attached to the stem.

Leaf Structure and Arrangement

Leaf parts - The basic parts of a leaf are the petiole, the base, and the blade. See Figure 1.3. The petiole is the leaf stalk which connects the leaf to the stem. The base is the bottom area of the leaf where the petiole connects to the blade. Stipules are small leaflike structures sometimes found at the base of the leaves on some trees. They usually occur in pairs. The blade is the flat, large part, containing leaf tissue, a midrib (the large central vein from which all other veins branch), and veins. Photosynthesis and respiration occur in the leaves.

Figure 1.3 - Leaf Parts

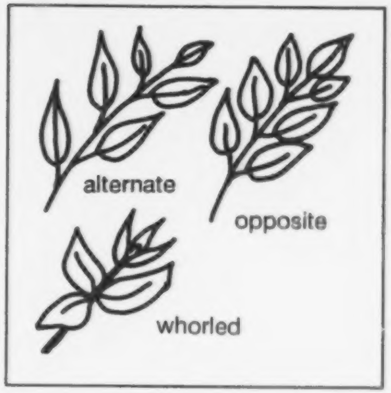


The blade surface texture is characterized in one of the three following ways.

1. Glabrous - smooth, shiny, hairless
2. Pubescent - surface covered with hair
3. Glacous - covered with fine, waxy, whitish bloom

Leaf and bud arrangement - Leaves and buds can be attached to the stem in different arrangements. These can be alternate, opposite, or whorled. See Figure 1.4.

Figure 1.4 - Leaf and Bud Arrangement


alternate
opposite
whorled

Venation - Leaves are another identifying feature of a tree. There are two types of netted venation. In palmate venation, all of the main veins fan out from the same point at the base of the blade. Pinnate venation has the midrib running the length of the blade, and smaller veins branching out from it. See Figure 1.5.

Leaf type - Figure 1.6 diagrams the types of leaves. Leaf structure is characterized by one of the following.

1. Simple - One blade rises from the petiole.
2. Compound - More than one leaf or leaflet rises from the petiole.
    a. Palmate - All the leaflets attach to the same point at the tip of the petiole.

Figure 1.5 - Leaf Venation

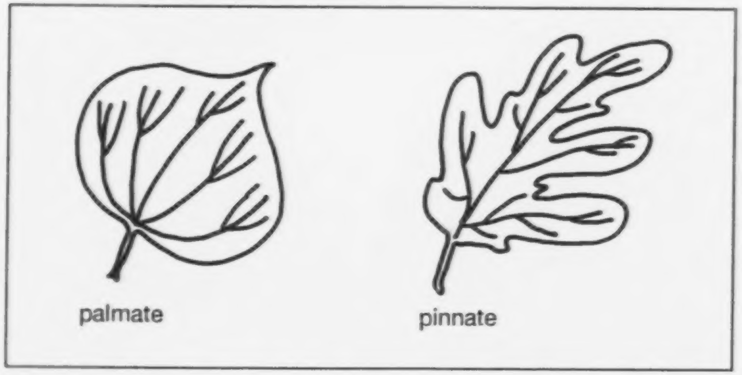

palmate
pinnate

Figure 1.6 - Leaf Types

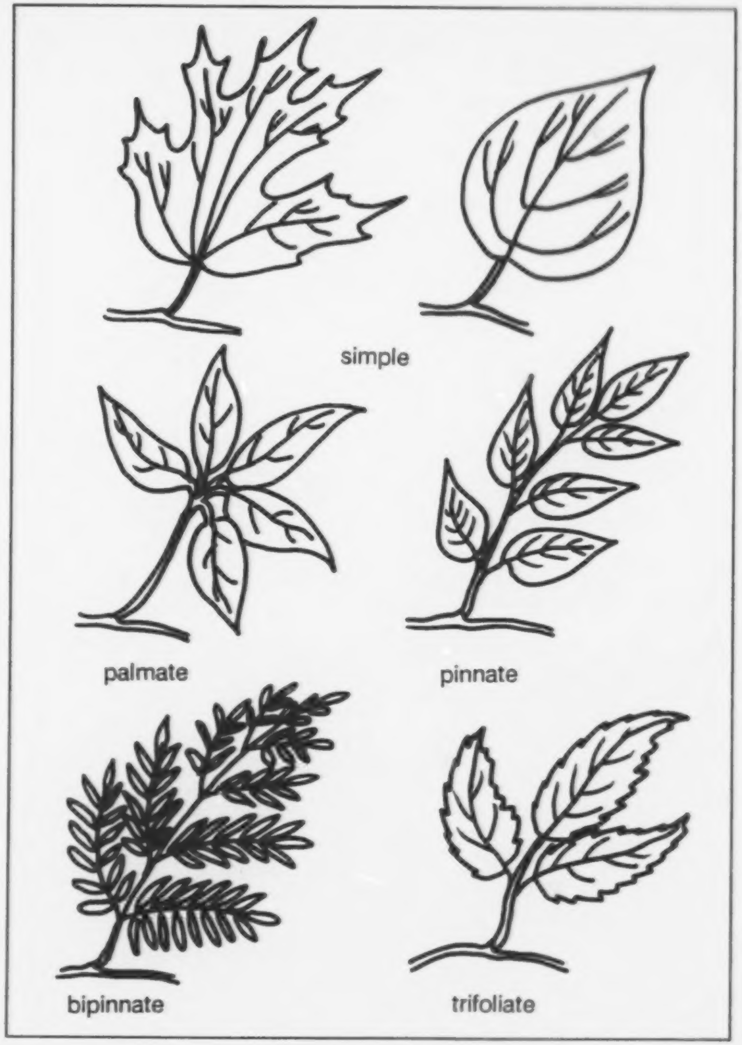
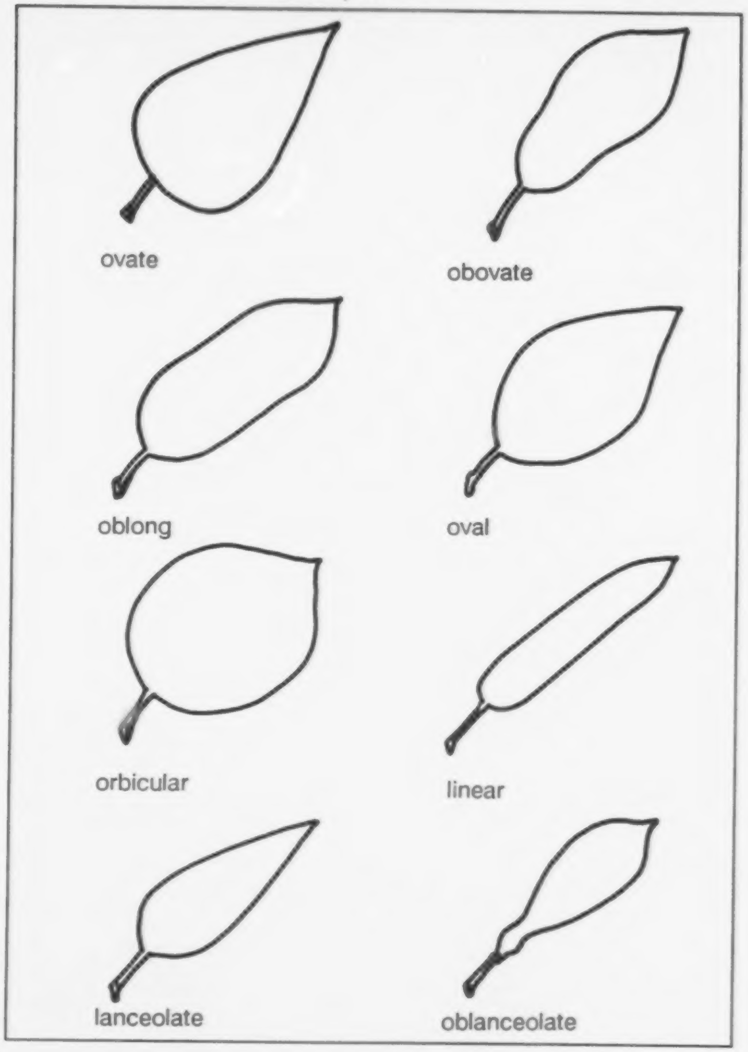

simple
palmate
pinnate
bipinnate
trifoliate

Figure 1.7 - Common Leaf Shapes


ovate
obovate
oblong
oval
orbicular
linear
lanceolate
oblanceolate

b. Pinnate - Compound leaves have a long stem, or rachis, to which the smaller leaves or leaflets are attached.
c. Bi-pinnately compound leaves are divided twice.
d. Trifoliate has three palmately-compound leaflets.

Leaf anatomy - Leaf shapes, margins, tips, and bases can all be used in identifying plants. The leaf shape is the overall silhouette of the leaf. It shows whether a leaf is long and thin, fat at one end and thin on the other, or round or oval shaped. Some of the more common shapes are shown in Figure 1.7.

Leaves have differently shaped margins. The margin is the outside edge of the leaf blade. Some of the more common leaf margins are shown in Figure 1.8.

The base of a leaf shows the shape of the blade where it intersects with the petiole. Some of the more common base shapes are shown

Figure 1.8 - Common Leaf Margins

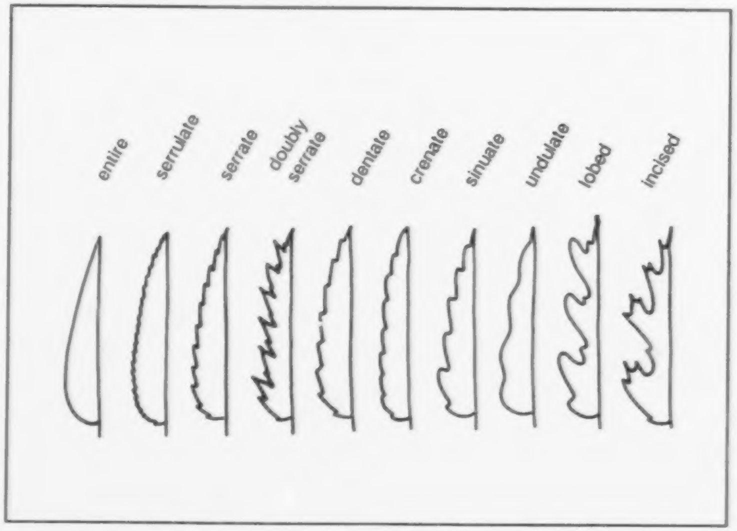
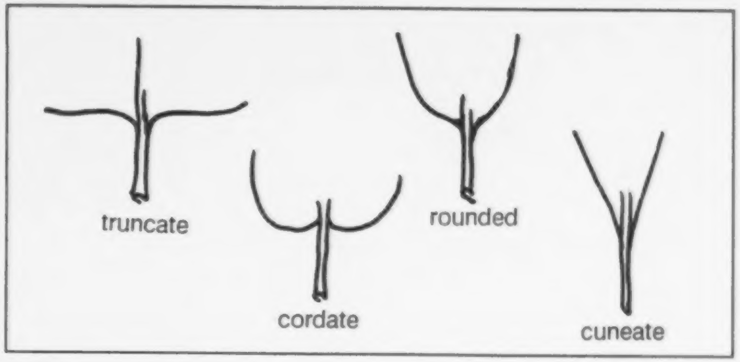

entire
serrulate
serrate
doubly serrate
dentate
crenate
sinuate
undulate
lobed
incised

Figure 1.9 - Common Base Shapes

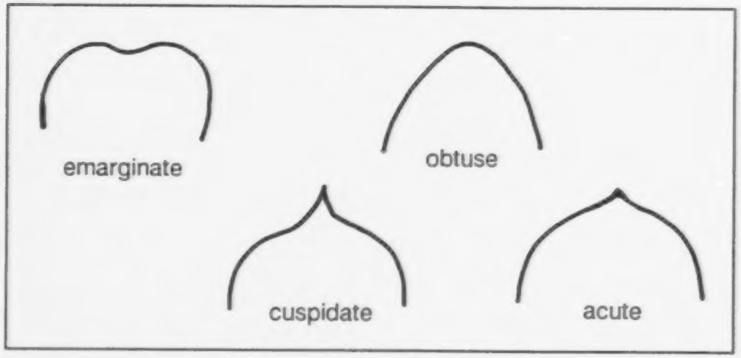


in Figure 1.9. The tip or apex of a leaf can be found in different shapes. Figure 1.10 illustrates examples of some of the more common leaf tip shapes.

Summary

Most plant leaves have the same basic structure: blade, tip, base, and margin. However, each species of plant may have unique characteristics. Just as most humans have a head, torso, arms, and legs; each individual person may have a different size and shape of head, torso, arms, and legs.

Figure 1.10 - Common Tip Shapes



All of these leaf shapes; margin, tip, and base shapes do not necessarily need to be memorized; but in working more with plants, one gradually learns which tree has which characteristic.

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Narrow-leaf evergreens are popular because they stay green year-round, offering continuous, green color throughout winter when other plants are dormant. They can also adapt to various soil types and weather conditions.

Leaf Types

Characteristics by which narrow-leaf evergreens are identified differ from those used to identify deciduous plants. Their most distinguishing characteristic is leaf type. Leaf types are illustrated in Figure 2.1.

Awl-like - Awl-like foliage is very sharp to the touch. This needle is characteristic of the juvenile growth stage of many junipers.

Scale-like - Scale-like foliage has leaves that look like scales overlapping each other like shingles on a roof. This foliage forms a flat spray and is relatively soft to the touch. Arborvitae (Tsuja) and mature juniper have scale-like leaves.

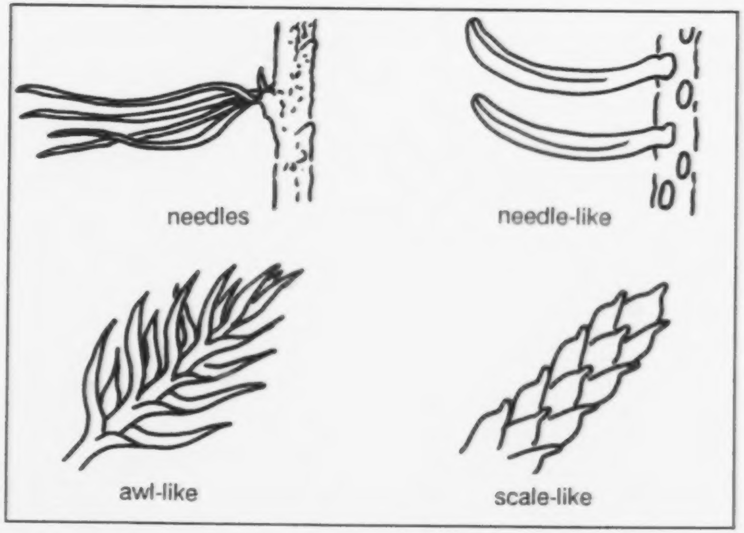


Figure 2.1 - Leaf Types

Needle-like - Needle-like leaves are the third type. In pines, needles are attached to the branch in clusters of two, three, or five by fascicles or sheaths. Linear-shaped needles are found on species like fir, spruce, cedar, and yew.

Other characteristics - The length of needles can be an identifying characteristic, although environmental conditions may change the average length of needles. Therefore, identification by needle length can be misleading. Some species are characterized by stiffness or softness of needles. White pine, for instance, has very long, slender, soft needles; whereas the Austrian pine has stiff, sharp needles that can hurt a person when touched. The shape of the needle can also help identify narrow-leaf evergreens. For example, spruce (Picea) has square-shaped needles with four sides and cedar (Cedrus) usually has triangular-shaped needles.

Genus Characteristics

Figure 2.2 illustrates the various genera characteristics of narrow-leaf evergreens.

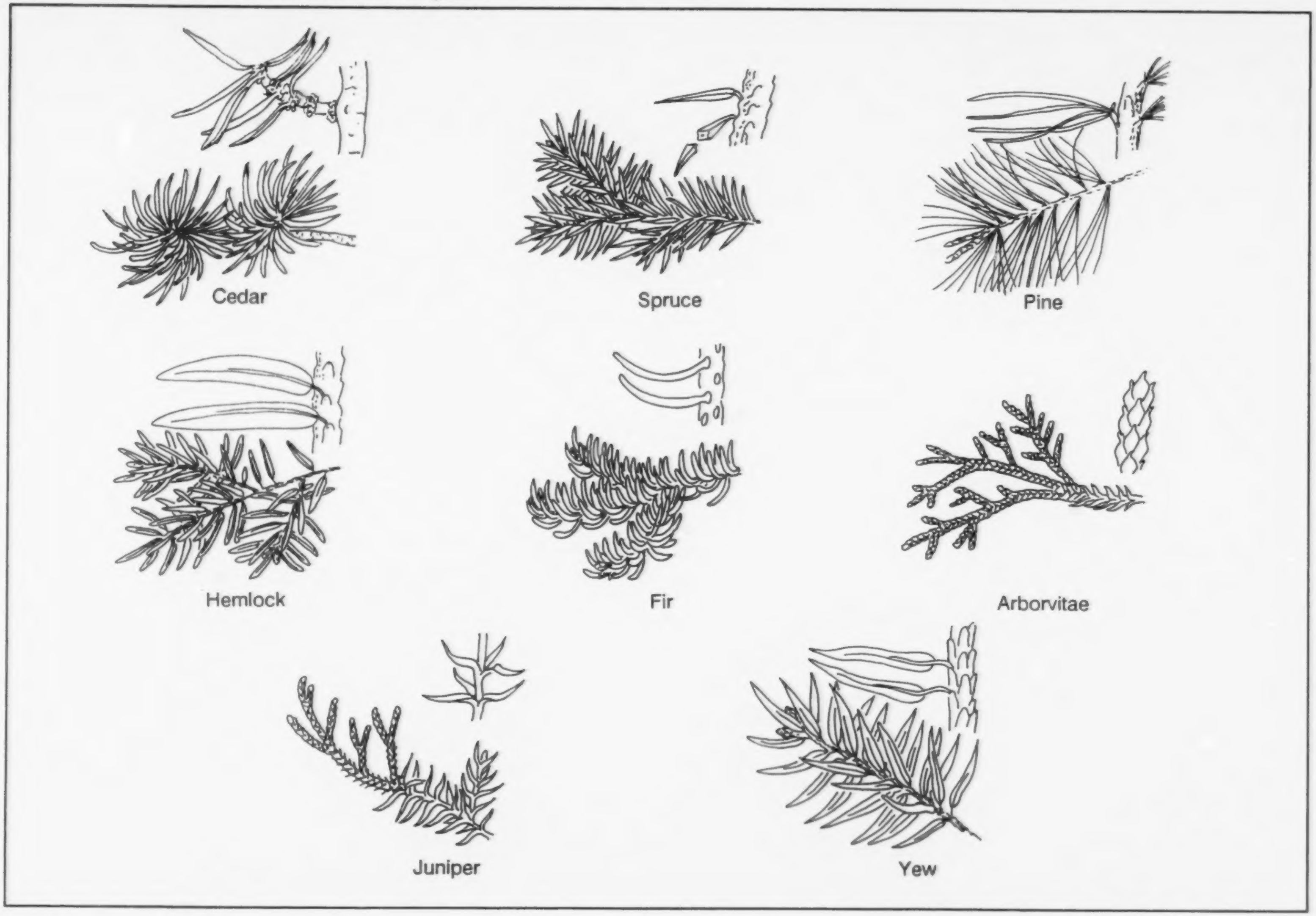
Pine - Pine (Pinus) has generally long, needle-like leaves; which are borne in a cluster of two to five; and spirally arranged on a stem.

Cedar - Cedar (Cedrus) has short, stiff, triangular-shaped, needle-like leaves, scattered along the branches and usually clustered on spurs of ten or more leaves per cluster.

Spruce - Spruce (Picea) has short, stiff, needle-like leaves of uniform width. They are usually four-angled, sharp-pointed, and scattered all around the twig. The twigs are very rough after the needles fall.

Hemlock - Hemlock (Tsuga) has flat, linear, needle-like leaves of less than three-fourths inch long that are on a short stalk and usually in two ranks. The leaves are notched at the end and white beneath.

Figure 2.2 - Characteristics of Narrow-leaf Evergreens



Cedar

Spruce

Pine

Hemlock

Fir

Arborvitae

Juniper

Yew

Fir - Fir (Abies) has flat, linear, needle-like leaves placed spirally around the twig. The twig is smooth after the leaves fall.

Arborvitae - Arborvitae (Thuja) has small, scale-like leaves in pairs that arise along a short, central stalk. The leaves overlap tightly on a flattened branchlet. They are soft to the touch.

Juniper - Juniper (Juniperus) has a mixture of scale-like and awl-like leaves. The scale-like leaves closely surround the stem, whereas the awl-like leaves point outward. They are harsh to the touch.

Yew - Yew (Taxus) has flattened, linear leaves, mostly green on both surfaces, often in two ranks, curved, and scythe-shaped.

Summary

Although there are other detailed characteristics that can be used, these are a few used for general identification of narrow-leaf evergreens. When identifying a species, such as whether a tree is a white pine or an Austrian pine, the general characteristics will stay the same. They will both have needle-like leaves. However, other characteristics may change, such as number of needles per sheath, or softness and stiffness of needles. Some of these genera grow as shrubs and some as trees. The characteristics studied in the previous lesson; such as form, branching, and growth habit; are also used when identifying narrow-leaf evergreens.

Credits

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This lesson draws from the general identifying characteristics found in Lessons 1 and 2. Tables 3.1, 3.2, and 3.3 include the information necessary to identify selected shade trees, flowering trees, and evergreen trees.

Most of the plants covered in this unit are ones that are good choices for successful planting in Missouri. There are plants listed that are not good choices. Although commonly such plants have been used in Missouri landscapes, their use has been unsuccessful. One should be aware of undesirable plants, and what makes them undesirable, as well as desirable plants.

The plants in this unit are listed by genus and species (botanical name). Common names are not always reliable, since there may be up to 250 common names for one plant. To be sure a landscaper and a client are referring to the same plant, the botanical name should be used.

The genus is always capitalized and underlined. A genus is a closely related group of plants that have similar characteristics. Within a genus, there are usually one or more species.

Species names are always written with lowercase letters and underlined. Species, or specific epithet, is not clearly defined, it is a concept. A species is a group of plants within the genus that has marked identification features that are similar to each other, yet distinct from other species. A variety is a subordinate group of the species or sub-species. They usually have very unique differences which are inheritable. For example, Gleditsia triacanthos is the common Honey Locust that has thorns. Gleditsia triacanthos inermis is a thornless variety. Seeds from this variety will not produce thorny plants, whereas seeds from the species will.

Cultivars are listed behind the species with the first letter capitalized and with single quotation marks around them. Cultivar means cultivated variety. It is a group of plants that has the characteristics of the species, but also has distinct character differences from other plants. Those plants must be propagated vegetatively or crossbred to retain the cultivar. Their own seeds will not produce the cultivar. Cultivars are usually selected for a particular favorable characteristic; such as fall color, size or color of flower, or pest resistance. An example is Acer rubrum 'Red Sunset.' This is a maple cultivar selected for its brilliant, red, fall color.

There are sometimes hundreds of cultivars for each species, each having its own strongly desirable characteristics. Even though a species is not supposed to be hardy in a certain zone, a cultivar of that species may be hardy. When selecting a plant for the landscape, be sure the proper cultivar is used.

Summary

While characteristics of form, growth, branching habit, stem, bud, and leaves are needed in initial identification; they become second nature after working with the plants. This type of identification is essential in distinguishing one species from another. One should be able to identify these plants by sight, without the aid of the charts.

Credits

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SHADE TREES

Acer rubrum - red maple

Acer saccharum - sugar maple

Betula nigra - river birch

Betula pendula - European white birch

Fraxinus Pennsylvania - green ash

Gleditsia triacanthos inermis - honey locust

Liquidambar styraciflua - sweet gum

Liriodendron tulipifera - tulip tree

Plantanus occidentalis - sycamore

Quercus palustris - pin oak

Tilia cordata - littleleaf linden

Table 3.1 - Shade Tree Identification

COMMON NAME	BOTANICAL NAME	FORM	BRANCHING HABIT	GROWTH HABIT	STEM	BUDS	LEAF ARRANGEMENT	VENATION
Red Maple	*Acer rubrum*	upright to round	ascending	upright-spreading	red to green glabrous stems	terminal--blunt, scaled, clustered; lateral--scales	opposite	palmate
Sugar Maple	*Acer saccharum*	upright, oval	ascending low branches, upright-spreading	dense mass, upright to rounded	slender, brown stems with lenticels	terminal--long, pointed; lateral--1/2 the size of terminal buds	opposite	palmate
River Birch	*Betula nigra*	upright, oval, rounded with maturity	drooping with maturity	open; multiple trunks	pubescent, glabrous; turning reddish	terminal--small, 1/5" long, pubescent; reddish-brown; lateral--very small	alternate	pinnate
European White Birch	*Betula pendula*	oval	graceful, pendulous branches	single or multi-trunk; pyramidal-young	light tan, turning white with irregular, vertical black markings; glabrous	terminal--pointed, curved, brownish-black	alternate	pinnate
Green Ash	*Fraxinus pennsylvanica*	round to oval; irregular with maturity	3-5 main branches; dense, upright, upturned at ends	irregular with age	rounded, stout, glabrous to pubescent; leaf scar looks like a smile; green turning gray	terminal--dark rusty brown; lateral--smaller buds	opposite	pinnate
Honey Locust	*Gleditisia triacanthos inermis*	oval	zig zag stems, strong horizontal branching	open spreading, crown	smooth, reddish-brown zig zag stems	terminal--absent; lateral--small	alternate	pinnate
Sweet Gum	*Liquidambar styracifhia*	oval to irregualar	spreading	dense	corky ridges on dark brown stems	terminal--1/4 to 1/2" long, large, imbricate; reddish-brown; lateral--smaller	alternate	palmate
Tulip Tree	*Liriodendron tulipifera*	oval	high branched, spreading	massive	aromatic when broken; green to reddish brown	terminal--1/2" long, looks like ducks bill; greenish to reddish-brown; lateral--very small	alternate	pinnate

Table 3.1 - Shade Tree Identification continued

TYPE OF LEAF	LEAF SHAPE	MARGIN SHAPE	TIP SHAPE	BASE SHAPE	LEAF COLOR	BARK CHARACTERISTICS	LEAF SURFACE	UNIQUE CHARACTERISTICS
simple; 2-5" long	orbicular, 3-5 lobed	triangular ovate lobes; irregular teeth, v-shaped	acuminate	rounded to cordate	medium green; light green below; new leaves are reddish; red, scarlet in fall	light gray when young; dark gray and rough when mature	smooth; hairy veins below	new growth and petioles often red
simple; 3-6" across	orbicular to broadly obovate, 3-5 lobed	coarsely toothed	acuminate	cordate	medium green; yellow to red in fall	dark gray-brown	smooth	
simple; 1-3" long	ovate	doubly serrate	acute, pointed	cuneate to acute; wedge-shaped	medium green; yellow in fall	beige to reddish brown; exfoliating	impressed veins	
simple; 1 1/4 to 3" long	broad ovate	doubly serrate	acuminate	truncate	glossy green; paler below, yellow in fall	white, marked with dark patches, black with maturity	glabrous	
pinnately compound; 5-9 leaflets, 2-5" long	ovate to oblong, lanceolate	entire, crenate, serrate	acuminate	broad crenate	medium-dark green; paler under, yellow in fall	gray to gray-brown; ridged and furrowed	can be pubescent beneath	choose male or seedless form "Marshall Seedless"
pinnately or bipinnately compound; 6-8" long with alternate leaflets	up to 80 1/2-1" long oblong-lanceolate leaflets	slightly crenate	leaflet-obtuse	leaflet-oblique	dark green; yellow in fall	textured; gray to black	pubescent on midribs	interesting branching habit
simple; 4-7" across	nearly orbicular, 5-7 star shaped leaves	finely serrated lobes	acuminate	cordate	glossy lustrous green; yellow, red, scarlet and purple in fall	gray when yound, deeply furrowed with maturity	smooth	
simple; 3-6" long	nearly orbicular	4 lobes	nearly flat; truncate lobe	rounded to truncate	shiny green; paler below; yellow in fall	ash-gray textured	smooth	

Table 3.1 - Shade Tree Identification continued

COMMON NAME	BOTANICAL NAME	FORM	BRANCHING HABIT	GROWTH HABIT	STEM	BUDS	LEAF ARRANGEMENT	VENATION
Sycamore	*Platanus occidentalis*	oval to irregular	spreading	rounded head with maturity	stout, round, smooth or pubescent, yellow-brown, slightly zig zag; long internodes	terminal--absent; lateral--large, conical, dark brown	alternate	palmate
Pin Oak	*Quercus palustris*	pyramidal	lower branches hang down; upper branches ascend; middle branches are horizontal	dense, central leader	slender; greenish-brown	imbricate, conical, brown, pointed, 1/8" long	alternate	pinnate
Littleleaf Linden	*Tilia cordata*	upright; oval to pyramidal with maturity	dense	pyramidal when young	slender, brown stems	terminal--absent; lateral--long, reddish brown, egg-shaped buds	alternate	palmate

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Table 3.1 - Shade Tree Identification continued

TYPE OF LEAF	LEAF SHAPE	MARGIN SHAPE	TIP SHAPE	BASE SHAPE	LEAF COLOR	BARK CHARACTERISTICS	LEAF SURFACE	UNIQUE CHARACTERISTICS
simple; 4-12" across	5-lobed, broad-triangular lobes, ovate to reinform	coarsely toothed	acuminate	cordate	medium green; tan in fall	smooth upper gray, trunk has exfoliating bark in large pieces	pubescent along veins, below	
simple; 3-5" long	elliptical	5-7 deep lobes	acuminate	cuneate	dark green above; lighter beneath with tufts of hair; red or brown in fall; foliage persists into winter	brown to gray with maturity; lightly ridged	smooth	brown leaves remain on tree during the winter
simple; 1 1/2-2" long	orbicular	finely serrate	acuminate	cordate	dark green; yellow to red in fall	brownish-gray, ridged with maturity	glabrous, axillary tufts of brown hairs below	fragrant flowers attract bees

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FLOWERING TREES

Albizia julibrissin - mimosa

Cercis canadensis - eastern redbud

Cornus florida - flowering dogwood

Crataegus phaenopyrum - Washington hawthorne

Koelreuteria paniculata - golden raintree

Magnolia soulangiana - saucer magnolia

Malus species - flowering crabapple

Pyrus calleryana "Bradford" - Bradford pear

Table 3.2 - Flowering Tree Identification

COMMON NAME	BOTANICAL NAME	FORM	BRANCHING HABIT	GROWTH HABIT	STEM	BUDS	LEAF ARRANGEMENT	VENATION
Mimosa	*Albizia julibrissin*	broad-spreading, vase-shaped	arching	multi-trunk	slender, greenish, glabrous stem with lenticels	terminal--absent; lateral--2-3 small, brown, rounded scales	alternate	pinnate
Eastern Redbud	*Cercis canadensis*	rounded	horizontally ascending	multi-stemmed	dark brown or gray-tan with lenticles; zig zag	terminal--absent; lateral--1/8" long, flattened; sometimes two together	alternate	palmate
Flowering Dogwood	*Cornus florida*	semi-rounded	horizontal layered effect	wide spreading	slender, greenish to purple; pubescent in youth; scar encircles stem	terminal--flower bud at stem apex; flattened, 2 large scales cover it; lateral--small slender buds	opposite	pinnate; parallel to the margins
Washington Hawthorn	*Crataegus phaenopyrum*	oval to round; upright	low branching	multi-trunk; dense	brown slender; with 1-3" long thorn	terminal--larger scales, reddish; lateral--smaller, reddish, globular	alternate	pinnate
Golden Raintree	*Koelreuteria paniculata*	rounded, spreading	spreading and ascending	medium	stout with raised leaf scars; lenticels	terminal--absent; lateral--half elliptical, 2 scales	alernate	pinnate
Saucer Magnolia	*Magnolia soulangiana*	oval to rounded; irregular with maturity	spreading	multi-trunk	brown, glabrous with grayish lenticles; stipular lines encircle stem	terminal--pubescent, silky to the touch, 1/2 to 3/4" long, large, oval; lateral--smaller, short pubescent	alternate	pinnate
Flowering Crabapple	*Malus species*	oval to spreading	upright to spreading	multi-trunk	reddish brown	terminal--oval with scales; pubescent; lateral--oval with scales	alternate	pinnate
Bradford Pear	*Pyrus calleryana "Bradford"*	pyramidal to oval	vertical branching	upright branches	glossy brown	terminal--large wooly oval elongated buds, 1/2" long; lateral--same	alternate	pinnate

Table 3.2 - Flowering Tree Identification continued

TYPE OF LEAF	LEAF SHAPE	MARGIN SHAPE	TIP SHAPE	BASE SHAPE	LEAF COLOR	BARK CHARACTERISTICS	LEAF SURFACE	UNIQUE CHARACTERISTICS
bipinnately compound; 20" long	40-60 leaflets, 1/4-1/2" long	smooth, entire	acute	oblique	medium green; yellow in fall	gray, brown	sometimes pubescent on midribs on underside	interesting flowers; weak-wood
simple 3-5" long	broadly ovate	entire	acuminate	cordate, the petiole is swollen at the blade	dark green; yellow in fall	brownish-black; scales	glabrous to pubescent; glabrous underside	persistent fruit in winter; showy flowers
simple, 3" long	elliptic or ovate	entire-wavy	acuminate	cuneate to rounded	dark green; brilliant in fall, whitish underside	light-gray, textured	glabrous upper surface; glaucous underside; pubescent on veins	winter branching; 4 seasons of interest
simple, 1-3" long	triangular; ovate	3 to 5 sharply serrate lobes	acute	truncate or subcordate	dark green, paler underside; reddish in spring; yellow in fall	light to medium gray	smooth	leaf-like stipules may be present at base of leaf
pinnate or bi-pinnately compound; to 14" long	7-15 oval leaflets; 3" long	coarsely serrate; incisely lobed	acuminate	rounded	green; yellow in fall	light grayish-brown; lightly textured	glabrous; pubescent veins on underside	nice, persistent fruit in winter
simple, 3-6" long	obovate to broad-oblong	entire	acuminate, narrow, abruptly short-pointed	taper-pointed, rounded-cuneate	green; yellow to brown in fall	light gray	finely pubescent upperside and underside	
simple, 2-3" long	ovate to elliptic	serrate to entire	acute	rounded	green to red; yellow to red in fall	grayish-brown	smooth	showy flowers
simple, 1 1/2-2 1/2" long	broad-ovate	crenate	short, acuminate	rounded	glossy green; purple in fall	glossy brown turning gray-brown with maturity	glabrous	good fall color; fruit not important; nice in bloom

EVERGREEN TREES

Ilex opaca - American holly

Juniperus virginiana - Eastern red cedar

Magnolia grandiflora - southern magnolia

Picea abies - Norway spruce

Picea pungens "Glauca" - blue spruce

Pinus nigra - Austrian pine

Pinus strobus - white pine

Pinus sylvestris - Scotch pine

Tsuga canadensis - hemlock

Table 3.3 - Evergreen Tree Identification

COMMON NAME	BOTANICAL NAME	FORM	BRANCHING HABIT	GROWTH HABIT	STEM	BUDS	LEAF ARRANGEMENT	VENATION
American Holly	*Ilex opaca*	pyramidal	horizontal branching; low branching	densely open, irregular	slender; black stipules on each side of leaf scar	terminal--short, round, pointed; lateral--same	alternate	pinnate
Eastern Red Cedar	*Juniperus virginiana*	pyramidal to broadly pyramidal	horizontal branching, upward, curved branches	upright, spreading	reddish-brown	not important	whorls of 3	parallel
Southern Magnolia	*Magnolia grandiflora*	pyramidal; rounded in maturity	low branching	dense	green to gray-brown; pubescent	terminal--large, fuzzy; lateral--smaller, fuzzy	alternate	pinnate
Norway Spruce	*Picea abies*	pyramidal	horizontal branches with pendulous branchlets	retains low branches	slender; reddish-brown; glabrous	1/4" rosette shaped, brown buds	spreading around the stem	parallel
Blue Spruce	*Picea pugens "Glauca"*	broadly pyramidal	horizontal branches to ground	dense-compact	stout; orange-brown	conical with blunt tip, yellowish-brown	spreading around stem	parallel
Austrian Pine	*Pinus nigra*	pyramidal; oval in maturity	horizontal branching	dense, compact to open	rough with leaf bases	terminal--oval to oblong or cylindrical, 1/2-1" long with sharp point	spirally arranged clusters	parallel
White Pine	*Pinus strobus*	pyramidal to irregular; pyramidal in maturity	symmetrical; horizontal branching	symmetrical; soft appearance	green to greenish-brown; straight, slender	terminal--1/4" long oval, long pointed buds	spirally arranged clusters	parallel
Scotch Pine	*Pinus sylvestris*	irregular pyramidal	lower branches die with age	wide-spreading, open	green to brown; turning orange with maturity	terminal--oblong-ovate, 1/4-1/2" long	spiralling around stem	parallel
Hemlock	*Tsuga canadensis*	pyramidal	horizontal; pendulous with age to ground		roughened by persistent leaf bases	terminal--minute, oval with hairy scales; lateral--same	spirally arranged	parallel

Table 3.3 - Evergreen Tree Identification continued

TYPE OF LEAF	LEAF SHAPE	MARGIN SHAPE	TIP SHAPE	BASE SHAPE	LEAF COLOR	BARK CHARACTERISTICS	LEAF SURFACE	UNIQUE CHARACTERISTICS
simple; leathery	elliptical to elliptic-lanceolate	flattened with short spines, rarely nearly entire	acuminate, pointed with spin	truncate	dull, yellow-green	light gray, smooth	glossy, smooth	
scale like	awl shaped	pointed	pointed	NA	dull reddish-green	brownish-gray; peels with maturity	glaucous upperside; green underside	dull reddish color may not contrast with other plants
simple; leathery; 5-10" long	obovate-oblong or elliptic	smooth, entire	obtusely short-acuminate or obtuse	cuneate	shiny dark green; rust colored and pubescent on underside	dark grayish-green	leathery upperside; pubescent underside	
1/2-1" long squarish needles	straight or curved	smooth	blunt	NA	bright to medium green	reddish-brown; warty	glaucous	branches droop
3/4-1" long squarish needles with 4 angles	auricular, sharp pointed	encurved	pointed	NA	gray to blue-green	orange-brown	glaucous	blue color detracts from other plants
4-6" long sharp, stiff needles; 2 per bundle	straight or curved	minutely toothed	pointed; sharp to touch	leaf sheath present	sharp stiff; dark green	dark brown, furrow; gray mottled ridges	smooth	sticky, resinous sap
3-5" long soft needles; 5 per bundle	acicular, slender, flexible	finely serrate	pointed	leaf sheath usually absent	bluish to gray- green	thin smoother, grayish-brown	smooth	sticky, resinous sap
1 1/2 -3" long needles; 2 per bundle	twisted, stiff	minutely toothed	short pointed	NA	blue-green; yellowish-green in winter	reddish-orange; grayish-red-brown with maturity	glaucous	resinous sap
simple	2 ranked linear, obtuse or acutish, 1/4-2/3" long	minutely serrate	obtuse	rounded	dark green upper side; 2 whitish bands on underside	brownish-red to gray; scaly; deeply furrowed	obscurely grooved	

This lesson draws from the identifying characteristics discussed in Lessons 1 and 2. Tables 4.1 and 4.2 contain information necessary to identify selected shrubs. Shrubs are just as important as trees to a successful landscape. The information that is used to identify trees is also used to identify shrubs. However, it should be remembered that shrubs can take on different forms than trees. Branching or growth habit may also vary.

Again, in this lesson, botanical names are used as well as common names. Both should be learned.

Summary

The form, branching and growth habit, leaf size and shape, and other identifying characteristics of shrubs are important knowledge to a landscaper. These characteristics are used not only to identify a shrub, but to place it in the correct and pleasing spot in the landscape.

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FLOWERING SHRUBS

Berberis thunbergii - Japanese barberry

Cornus sericea - redosier dogwood

Chaenomeles speciosa - flowering quince

Euonymus alatus - winged euonymusor burning bush

Forsythia x intermedia - border forsythia

Ligustrum japonicum - wax leaf privet

Nandina domesticum - nandina or heavenly bamboo

Pyracantha coccinea - scarlet firethorn

Salix gracilistyla - rosegold pussy willow

Spirea vanhouttei - Vanhoutte spirea

Syringa vulgaris - common lilac

Table 4.1 - Flowering Shrub Identification

COMMON NAME	BOTANICAL NAME	FORM	BRANCHING HABIT	GROWTH HABIT	STEM	BUDS	LEAF ARRANGEMENT
Japanese Barberry	*Berberis thunbergii*	rounded; dense	multi-stemmed	very dense; broader than tall	slender, dark reddish-brown stems with small thorns at buds	terminal--ovoid, scales; lateral--located at axis of thorn with smaller bud on either side	alternate
Redosier Dogwood	*Cornus sericea*	broad spreading	multi-stemmed	spreads by underground stems; loose	slender, dark red stems with lenticels	terminal--hairy flowering bud sticks out from stem; lateral--vegetative buds are elongated	opposite
Flowering Quince	*Chaenomeles speciosa*	rounded; irregular	stiff branches; twiggy	open	slender, light brown spines	terminal--rounded, scaly; lateral--small conical, scaly	alternate
Winged Euonymus or Burning Bush	*Euonymos alatus*	upright; flat top; rounded	dense; upright	multi-stemmed	light brown with corky ridges	terminal--small with 4-6 scales conical, oval, acute, glabrous; lateral--same	opposite to subopposite
Border Forsythia	*Forsythia x intermedia*	rounded with arching branches	arching, upright, spreading	normal density	4-sided, yellowish brown stems with lines down stem and lenticels	lateral--vegetative and flowering, long, pointed, clustered at the nodes	opposite
Wax Leaf Privet	*Ligustreum japonicum*	upright to spreading round	upright to spreading	multi-stemmed	buds and stems at nearly right angles to branchlets; hairy, slender	lateral--small conical, scaly	opposite
Nandina Heavenly Bamboo	*Nandina domestica*	upright, irregular	unbranched stems; strongly vertical	spread by rhizomes	upright, rough dark brown bark with vertical lines	not applicable	alternate
Scarlet Firethorn	*Pyracantha coccinea*	upright; rounded; irregular	stiff; upright	open if unpruned	glossy brown with thorns	terminal--small; lateral--same	alternate
Rosegold Pussy Willow	*Salix gracilistyla*	rounded	low branching	broad	rather slender, light yellow-green stems	terminal--absent; lateral--1/5" oblong, rounded at apex; pubescent; flattened against stem	alternate
Vanhoutte Spirea	*Spirea vanhouttei*	rounded with pendulous branches	ascending branches arching to ground	dense; compact	slender, brown, rounded, glabrous stems	terminal--small; lateral--small	alternate
Common Lilac	*Syringa vulgaris*	upright, irregular; multi-stemmed; leggy	upright leggy, spreading	upright	leaf scars not connected by stipular lines; stout	terminal--large dual; lateral--angular with scales in pairs	opposite

Table 4.1 - Flowering Shrub Identification continued

VENATION	TYPE OF LEAF	LEAF SHAPE	MARGIN SHAPE	TIP SHAPE	BASE SHAPE	LEAF COLOR	BARK CHARACTERISTICS	LEAF SURFACE
pinnate	1/2-1 1/2" long; simple in clusters	obovate to spatulate	entire	rounded	oblique	medium green; reddish in fall	brown	glabrous upperside; glaucous underside
pinnate	2-5" long; simple	ovate to broad; ovate	entire	acuminate	rounded	medium-green; purplish in fall	red in winter	glaucous underside
pinnate	simple	ovate to oblong; 1-3" long	sharply serrate	acute	acute	glossy, dark green; yellow in fall	dark grayish-brown	lustrous
pinnate	simple; 1-2" long	elliptic to obovate	finely serrate	acuminate, acute	cuneate	dark green; brilliant red in fall	green when young; turning gray with age	smooth
pinnate	3-5" long; simple	narrowly ovate-elliptic	dentate in upper part of leaf, entire on bottom half	acute	cuneate	medium green; bronze in fall	yellowish brown	smooth
pinnate	simple; 1-2 1/2" long	elliptic-oblong, ovate	entire	acute	cuneate	glossy, dark green	medium gray, smooth	pubescent underside
pinnate	2-3 times compound; up to 30' long	leaflets--ovate; 1-2" long; 1/2-1" wide	entire	acute	acute	medium green; bright red in fall	rough dark brown with vertical lines	smooth
pinnate	simple; 1-1 1/4" long	narrow elliptic to lanceolate	lightly serrate-crenate	acute	cuneate	glossy, dark green	dark brown	smooth
pinnate	simple; 1 1/2-4" long	lanceolate	serrate	acuminate, pointed	cuneate	bluish-gray	ridged and furrowed	glaucous and silky underside
pinnate	simple	ovate to obovate; 3/4-1 1/2" long	toothed often obscurely; 3-lobed	pointed	tapering rounded	pale bluish-green; lighter underside; bronze-yellow in fall	dark grayish-brown; shreds on older wood	glabrous
pinnate	2-5" long; simple	ovate to broad; ovate	entire	acuminate	cordate	dark green, no fall color	dark gray to gray-brown	glabrous

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EVERGREEN SHRUBS

Buxus microphylla - Korean boxwood or littleleaf boxwood

Euonymus kirutschovicus - spreading euonymus

Ilex crenata "Helleri" - Japanese holly

Juniperus chinensis "Hetzii" - hetzii juniper

Juniperus chinensis "Phitzeriana" - phitzer juniper

Mahonia aquifolium - Oregon grape holly

Pinus mugo - mugo pine

Rhododendron catawbiense - catawba rhododendron

Taxus cuspidata - Japanese yew

Thuja occidentalis - Eastern or American arborvitae or white cedar

Viburnum rhytidophullum - leatherleaf viburnum

Table 4.2 - Evergreen Shrub Identification

COMMON NAME	BOTANICAL NAME	FORM	BRANCHING HABIT	GROWTH HABIT	STEM	BUDS	LEAF ARRANGEMENT
Korean Boxwood or Littleleaf Boxwood	*Buxus microphylla*	compact; rounded	dense	compact; spreading	slender; green	terminal--small, ovoid	opposite
Spreading Euonymus	*Euonymus kiautschovica*	broadly oval	broad spreading	multi-stemmed; will climb like a vine	slender, green, rounded	terminal--conical, sharp-pointed; greenish, tinged with red in winter	opposite
Japanese Holly	*Ilex crenata "Helleri"*	compact; dense; rounded	multi-branched; twiggy	dense, compact	slender green	terminal--small, inconspicuous; lateral--small	alternate
Hetzii Juniper	*Juniperous chinensis "Hetzii"*	spreading	45° branch angle	dense-compact; irregular; spreading	stout, ragged bark	terminal--small	cross arrangement when viewed from end of twig
Pfitzer Juniper	*Juniperus chinensis "Pfitzeriana"*	wide spreading	pendulous at tip; horizontal branching	dense, compact	stout; ragged bark	terminal--small	cross arrangement when viewed from end of twig
Oregon Grape Holly	*Mahonia aquifolium*	upright; irregular	upright	irregular, open, straggly habit	roundish, stout; leaf scars--narrow, low, half encircling the stem	terminal--large, oval shape with 6 scales; lateral--small	alternate
Mugo Pine	*Pinus mugo*	mounded	broad spreading, bushy	spreading	short without down turning; brown to blackish-brown	terminal--1-4 to 1/2" oblong bud with reddish-brown scales, encrusted with resin;	2 in a bundle, may last for 5 years
Catawba Rhododendron	*Rhododendron catawbiense*	rounded	low to ground	taller than wide	brown with age	terminal--large flower buds; lateral--large 1/2" long, scaly, pointed, yellowish-green	alternate
Japanese Yew	*Taxus cuspidata*	broad oval; compact; irregular	upright-spreading	dense-compact; irregular; spreading	green turning reddish-brown	terminal--ovoid, oblong; lateral--oval to oblong, chestnut brown, overlapping	spirally arranged
Eastern or American Arborvitae; White Cedar	*Thuja occidentalis*	pyramidal	short ascending branches to ground	upright; horizontal sprays	alternate, compressed, flat stems	not important	overlapping scales
Leatherleaf Viburnum	*Viburnum rhytidophyllum*	upright; oval to rounded	loosely branched; upright	upright; strongly multi-stemmed	gray to brown with pubescence; older stems become glabrous	terminal--large 1/2" oblong, fuzzy buds; lateral--large, rusty-colored, vegetative buds; 1 1/2-2" flowering buds	opposite

Table 4.2 - Evergreen Shrub Identification continued

VENA-TION	TYPE OF LEAF	LEAF SHAPE	MARGIN SHAPE	TIP SHAPE	BASE SHAPE	LEAF COLOR	BARK CHARACTERISTICS	LEAF SURFACE
pinnate	simple; 1/2-1" long	obovate	entire	rounded	cuneate	green; yellow to brownish-yellow in winter	light tan	smooth
pinnate	simple; 2-3" long	broad-elliptic or obovate	crenate-serrate	acute to obtuse	cuneate	green; rusty-green in winter	green stems with age; changing to gray-brown	smooth
pinnate	simple; 1/2-1 1/4" long	obovate to oblong	crenate-serrate	obtuse	acute to broad-cuneate	dark green	green young stems maturing to yellow-brown	glabrous
not important	needle and awl	scale-like; a few awl-shaped	smooth	pointed	rounded	blue-green	dark brown, splitting, peeling	glaucous
not important	scale and awl-like	juvenile--awl-shaped; adult--scale-like, obtuse, thickened	smooth	pointed	rounded	gray-green	dark brown; splitting, peeling	glaucous
pinnate	compound; 5-9 leaflets; 6-10" long	ovate to oblong-ovate	sinuately spiny-dentate	acute	rounded-truncate	dark green; holly-like; purplish-bronze in fall	light brown	smooth/shiny; stiff
parallel	in pairs of 2; 2" long	rigid, curved	finely toothed	short, blunt, horny point	rounded	medium green	brown	stomatic lines on both surfaces
pinnate	simple; 2-5" long	elliptic to oblong	entire, smooth	obtuse, cuspidate	rounded	dark green; yellow-green underside	rusty	glabrous; leathery
parallel	needle; 1" long	linear; usually 2 ranked	entire	cuspidate	rounded	dark green; yellowish underside	reddish-brown	smooth
not important	scale-like, abruptly pointed on main axis; glandular	scale-like; pointed	not important	pointed	rounded	dark green; brownish-yellow in winter	reddish- to grayish-brown	scaly
pinnate	simple; 2-8" long	ovate-oblong to ovate-lanceolate	entire	acute or obtuse	rounded or subcordate	dark green; light to white on underside	medium grayish- brown	glabrous; strongly wrinkled upperside; leathery

This lesson draws from the identifying characteristics discussed in Lessons 1 and 2. Tables 5.1 and 5.2 contain information necessary to identify selected vines, ground covers, and perennials.

When identifying these plants, the stems are often an insignificant characteristic. Many perennials do not have stems. Instead, their leaves grow directly from a clump or crown in the ground. Many times the flower is the most significant identifying characteristic, rather than the leaves. Sometimes the form of the plant as a whole, is the most significant factor. For example, lily turf grows like a thick clump of grass with arching leaves; whereas, silver mound grows as a rounded mound of lacy, silvery leaves.

Summary

Vines, ground covers, and perennials can be used effectively in the landscape. They can be used in places where no other plant can be used. To make the best use of them, the landscaper must be able to identify those that have characteristics that will fit into the landscape design.

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GROUND COVERS AND VINES

Ajuga reptans - ajuga or bugleweed

Celastrus scandens - American bittersweet

Coronilla varis - crown vetch

Euonymus fortunei "Radicans" - bigleaf wintercreeper

Hedra helix - English ivy

Juniperus horizontalis - creeping juniper

Lonicera japonica "Halliana" - Hall's honeysuckle

Vinca minor - creeping myrtle or periwinkle

Table 5.1 - Ground Cover and Vine Identification

COMMON NAME	BOTANICAL NAME	FORM	BRANCHING HABIT	GROWTH HABIT	STEM	LEAF ARRANGEMENT	VENATION
Ajuga or Bugleweed	*Ajuga reptans*	irregular	grows in a clump	mat-like ground cover	roots form along stems; square flower stems	opposite	pinnate
American Bittersweet	*Celastrus scandens*	irregular	spreading	twining vine; woody vine	not important	alternate	pinnate
Crown Vetch	*Coronilla varis*	sprawling	prostrate or ascending stems	vine-like herb	brown in winter; green in growing season	leaflets opposite	pinnate
Bigleaf Wintercreeper	*Euonymus fortunei "Radicans"*	irregular	irregular; erect, dense branches	trailing or climbing evergreen vine	green-purple, gray with age	opposite	pinnate
English Ivy	*Hedra helix*	irregular	spreading	trailing on the ground or climbing by aerial rootlets; woody vine	reddish	alternate	pinnate
Creeping Juniper	*Juniperus horizontalis*	prostrate	semi-upright or low irregular spreading	erect trailing habit	not important	flattened close to stem, overlapping	NA
Hall's Honeysuckle	*Lonicera japonica "Halliana"*	irregular	spreading	climbing; woody vine	slender, hairy	opposite	pinnate
Creeping Myrtle or Periwinkle	*Vinca minor*	mat-forming	irregular	trailing	slender, arching, drooping green	opposite	pinnate

Table 5.1 - Ground Cover and Vine Identification continued

TYPE OF LEAF	LEAF SHAPE	MARGIN SHAPE	TIP SHAPE	BASE SHAPE	LEAF COLOR	LEAF SURFACE	UNIQUE CHARACTERISTICS
simple	basal--oblong, elliptic or ovate; upper--elliptic or ovate	entire wavy or blunt serrate	rounded	narrowed to petiole	shiny green, burgundy	smooth	NA
simple	elliptic to obovate, 1 3/4" to 4 1/2" long, up to 2 1/4" wide	toothed, lightly serrate	acute	rounded	bright yellow in fall	smooth	NA
compound	leaflet--oblong to obovate, 1/2" long	entire	rounded	rounded	gray-green	smooth	NA
simple	1 1/2" to 2" long, elliptical; 1/2 to 1 1/2 " wide	wavy, smooth to slightly crenate or serrate	acute	cuneate	dark green	smooth shiny	aerial roots; large terminal buds with sharp points
simple	juvenile--3-5 lobes, 2-5" diameter; mature--less lobed	lobed	acute	rounded	mature--deep green upper-side yellow-green under-side; young--light green	pubescent on underside	NA
needle-like	scale-like and awl-like	NA	pointed	rounded	blue-green to greenish; purple in winter	NA	NA
simple	ovate to oblong, 1 1/2" to 3" long	smooth	acuminate	rounded	dark green	hairy on both sides	NA
simple	1/2" to 1 1/2 " long; 1/2" wide; elliptic to lanceolate	entire	acute	acute	blue-green	glossy, wavy upper surface	NA

PERENNIALS

Artemisia schmidtiana - silver mound

Astilbe x ardendsii - false spirea astilbe

Aquilegia hybrids - columbine

Chrysanthemum hybrids - garden mum

Coreopsis lanceolata - coreopsis

Hemerocallis hybrids - day lily

Heuchera sanquinea - coral bells

Hosta species - plantain lily or hosta

Liriope spicata - lily turf

Phlox subulata - creeping phlox

Table 5.2 - Perennial Identification

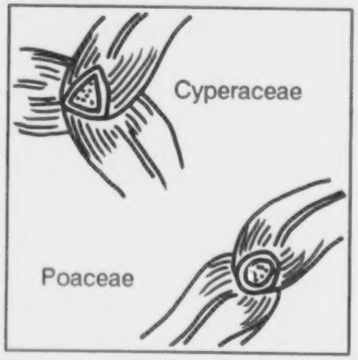
COMMON NAME	BOTANICAL NAME	FORM	BRANCHING HABIT	GROWTH HABIT	STEM	LEAF ARRANGEMENT	VENATION
Silver Mound	*Artemisia schmidtiana*	rounded mound	upright	rounded mound		alternate	palmate
False Spirea Astilbe	*Astilbe x ardendsii*	erect	upright	rounded habit with spiked flowers		whorled	pinnate
Columbine	*Aquilegia hybrids*	erect stems	erect	several stems rising from a thickened root stock; flowers rise above foliage		whorled	palmate
Garden Mum	*Chrysanthemum x morifolium*	columnar to round mound	rounded; erect stems	rounded habit		alternate	pinnate
Coreopsis	*Coreopsis lanceolata*	irregular, upright, sprawling	upright, sprawling	upright, sprawling		opposite	pinnate
Day Lily	*Hemerocallis hybrids*	rounded with upright flower stalks	upright, arching branches	mound-like shape of foliage	NA	grow from a clump at base	parallel
Coral Bells	*Heuchera sanguinea*	rounded clump with upright flower stalks	upright	rounded clump	hairy; reddish color	grow from the root stalk	palmate
Plantain Lily or Hosta	*Hosta species*	rounded mound	upright	upright, arching leaves; spike flowers	NA	grow from clump at base	parallel
Lily Turf	*Liriope spicata*	dense grass-like mat or clump	upright, arching	upright, arching; forming a dense mound	no aboveground stem showing	grow from clump at base	parallel
Creeping Phlox	*Phlox subulata*	prostrate mound, dense	irregular	mat forming		opposite in pairs or alternate; crowded	pinnate

Table 5.2 - Perennial Identification continued

TYPE OF LEAF	LEAF SHAPE	MARGIN SHAPE	TIP SHAPE	BASE SHAPE	LEAF COLOR	LEAF SURFACE	UNIQUE CHARACTERISTICS
compound twice palmately divided into linear segments	1 3/4" long, linear	smooth	acute	narrowing into petiole	silvery-white	silvery-white; hairs; velvety texture	NA
simple or twice or thrice compound	leaflets--ovate to oblong	doubly serrate	acute	rounded	dark green or bronze	smooth	NA
twice or thrice compound	leaflet--wedge shaped to nearly round	notched	deeply incised	cuneate	yellow-green	smooth	NA
lower--pinnate compound; upper--simple	upper--lanceolate to ovate, 3" long or smaller	upper--lobed 1/3 to 1/2 depth of blade; lobes entire or coarsely toothed	acute	rounded	upper surface--green to gray; underside--gray-green	underside pubescent	strongly aromatic
compound	needle-like	smooth	pointed		dark green	smooth	
simple	strap-like, linear, sword shape	smooth	grass-like, pointed	narrows toward basal clump	bright green	smooth	NA
simple	reniform	lobed serrate	round	rounded	dark, bright green; some with silver markings	hairy	NA
simple	varies with species	smooth to wavy	acuminate	forms tube-shaped stalk; narrows towards basal clump	NA	smooth	flower stalks have bell-shaped flowers
simple	linear, wide, 8" to 20" long; 1/4" wide	minutely serrate	acute	narrows towards basal clump	NA	smooth	NA
simple	linear subulate up to 1" long; needle-like	ciliate	pointed	narrowing to stem	dark green	smooth	stiff leaves, close together

There are three families in the order of Monocots. These are cyperaceae - sedges, which are characterized by triangular shaped stems in cross section, and are solid with pith; juncacaea - rushes or reeds, which are characterized by a round stem with a springy pith inside; and poacea - grasses, which are characterized by a round stem, usually hollow or with pith with two leaves opposite each other. In turf identification only cyperaceae and poacea are important. See Figure 6.1.

Figure 6.1 - Cyperaceae and Poaceae


Cyperaceae
Poaceae

The family of grasses, Poacea, will be discussed here. Grasses are difficult to identify in their vegetative state. But since many grasses do not flower until late in the season, it is often necessary to identify the grass by vegetative characteristics earlier in the season. In order to apply correct cultural practices such as mowing, fertilizing, pest treatment, and disease prevention, the landscaper must know what the plants are.

Structural Parts of a Grass

The parts of a grass plant include the roots, node, internode, leaf blade, collar, auricle, ligule, leaf sheath, cull (stem), and flower. See Figure 6.2.

Identifying Characteristics

Roots - The root systems differ between annual and perennial grasses. An annual usually has a weak, fibrous, root system that pulls out of the ground easily without tearing the top from the roots. A perennial usually has a strong fibrous root system and may or may not have rhizomes. It does not pull from the ground without breaking away from the roots and rhizomes.

Figure 6.2 - Parts of a Grass Plant

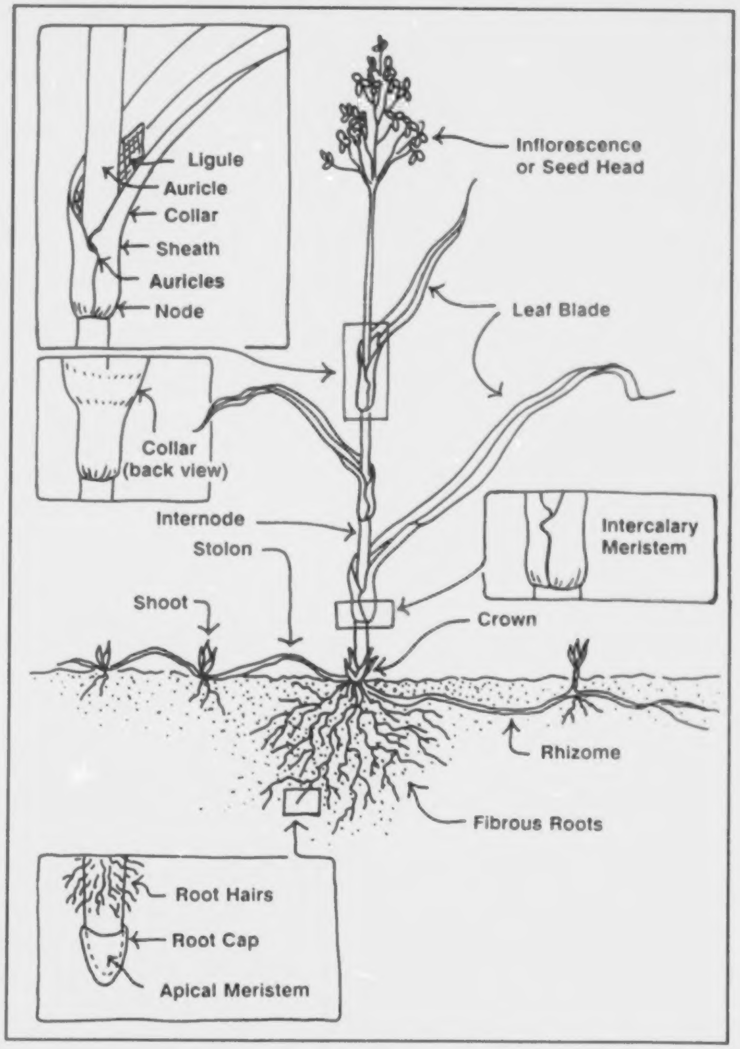
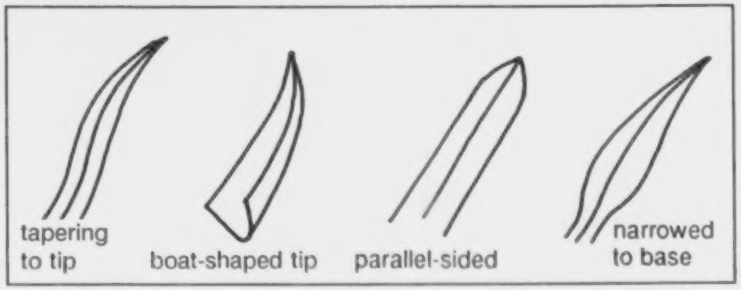

Ligule
Auricle
Collar
Sheath
Auricles
Node
Inflorescence or Seed Head
Leaf Blade
Collar (back view)
Internode
Stolon
Intercalary Meristem
Shoot
Crown
Rhizome
Fibrous Roots
Root Hairs
Root Cap
Apical Meristem

Figure 6.3 - Leaf Shapes


tapering to tip
boat-shaped tip
parallel-sided
narrowed to base

Leaf Shape - The leaf offers several identifying characteristics. The width, length, and hairiness of the blade differ in each genus and also vary with the environment. The leaf blade shape and the leaf tip shape are more definitive identifying characteristics. See Figure 6.3 for examples of those shapes.

Collar - The collar on a grass blade is the external narrow band found in the place where the blade and the sheath join. It can form different shapes, have different colors, and be with or without hair. Figure 6.4 shows the different collar shapes.

Figure 6.4 - Collars

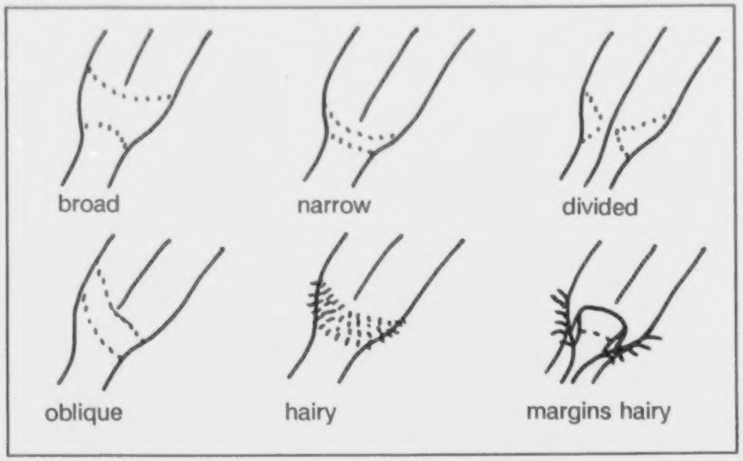
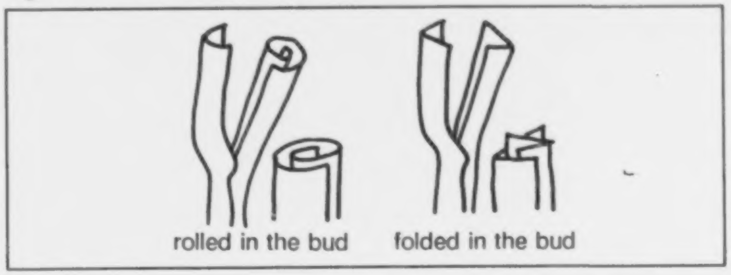

broad
narrow
divided
oblique
hairy
margins hairy

Figure 6.5 - Leaf Bud Arrangements


rolled in the bud
folded in the bud

Venation - Venation is the arrangement of the leaves in the bud shoot. There are two ways the leaves are arranged; folded, or rolled. To determine which arrangement exists, look at the way the new leaf naturally emerges from sheath or find the last fully emerged leaf and cut the sheath just below the collar. See Figure 6.5 for leaf bud arrangements.

Sheath - The sheath is the part that encircles the stem and the bud shoot. Usually, in a cross section, the sheath will be round (or nearly round) if the bud shoot is rolled; and flat if the bud shoot is folded. There are some exceptions. The sheath may be open or split, closed, or open with overlapping margins. See Figure 6.6 for examples.

Figure 6.6 - Sheaths

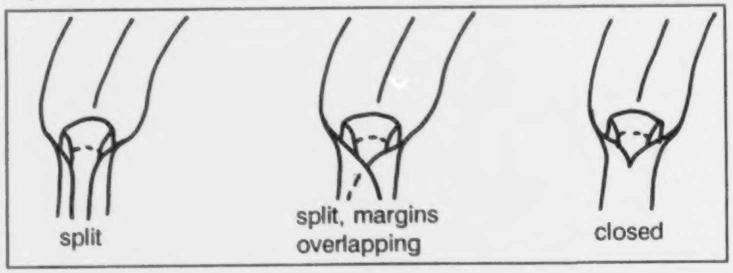
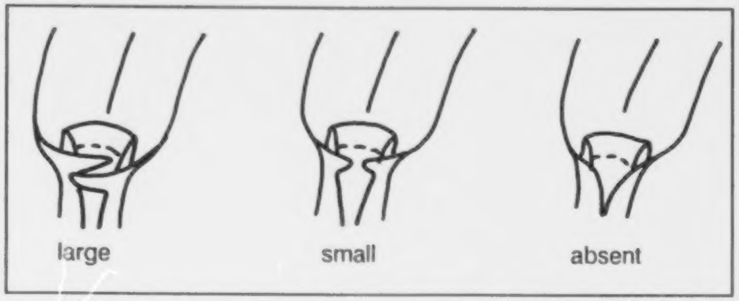

split
split, margins overlapping
closed

Figure 6.7 - Auricles



Auricles - The auricles are flap-like appendages at the top of the leaf sheath that may or may not clasp the stem. See Figure 6.7 for examples.

Ligule - The ligule is the upright projection of tissue at the internal junction of the blade and the sheath. The shapes, texture, and length are usually the same in each species. They do not vary much based on environment. The ligule shapes are found in Figure 6.8.

Inflorescence - The inflorescence or seed head of a grass can help in identifying grasses. There are three arrangements of flowers. These are spike, raceme, and panicle. Panicle is the most common. This inflorescence is triangular in shape with small seeding branches off the main stem holding the spiklets. This spiklet is made up of one or more flowers. See Figure 6.9 for details.

Figure 6.8 - Ligules

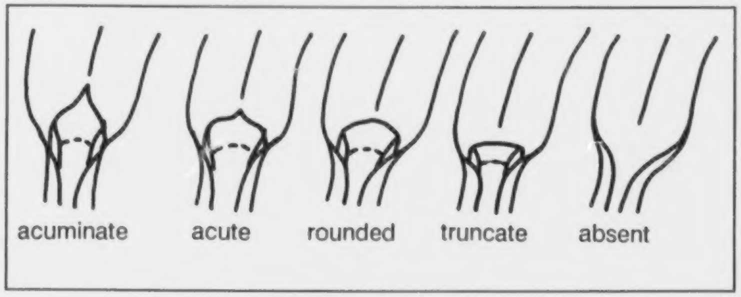
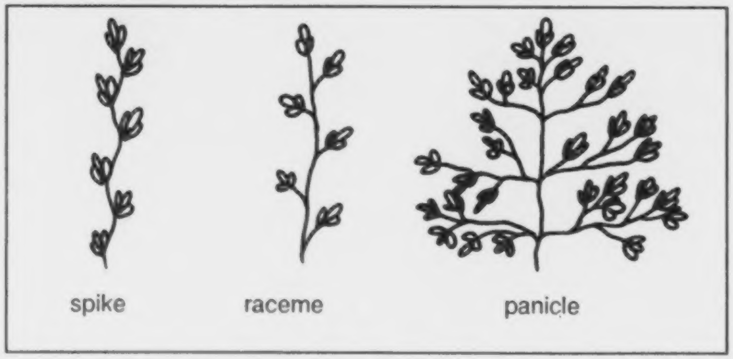


Figure 6.9 - Inflorescence



Summary

The Poacea family of grasses are the most often used lawn cover. Various species have specific requirements and need different types of care. In order for landscape maintenance workers to give the proper care they must be able to identify one grass species from the other. The leaf blade, collar, auricle, ligule, leaf sheath, and sometimes the flower are the keys to identifying grass species.

Credits

Kucera, Clair L. The Grasses of Missouri. 1st ed. Columbia, Missouri: Curators of UMC, 1961.

Diecker, William W. Grasses and Grasslike Plants of Cultivated Fields and Pastures in Missouri. Identification by Vegetative Characteristics. 1st ed. Columbia, Missouri: UMC - Integrated Pest Management Program, 1980.

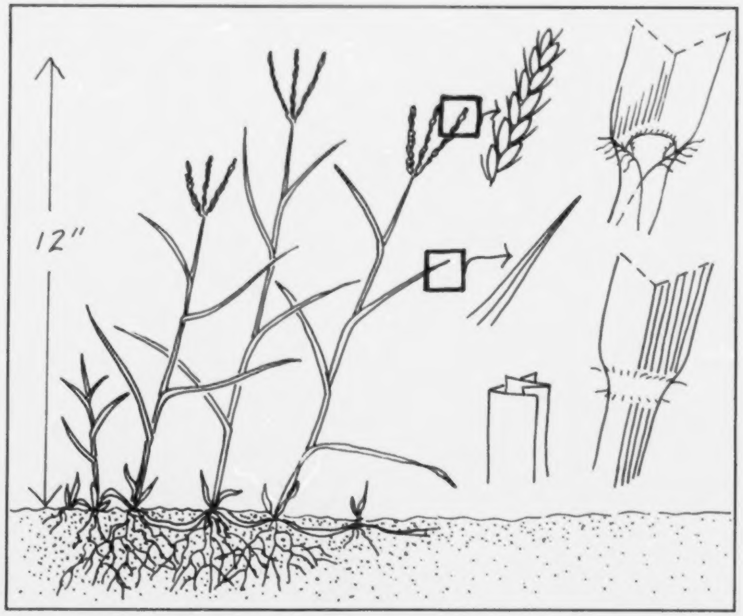
Scott's Professional Turf Manual. Marysville, Ohio: UM Scott and Sons, Co., 1981.

Ingels, Jack E.. Ornamental Horticulture: Principles and Practices. 1st ed. Albany: Delmar Publishing Co., Inc., 1985.

There are six major turfgrasses that are commonly used in Missouri. Landscapers should be familiar with identifying characteristics of each.

Bermudagrass - Bermudagrass, Cynodon dactylion, is an aggressive, warm-season, perennial grass spreading by stolons and rhizomes. It is a fine-textured, dark, blue-green grass that forms a tightly knit turf. It naturally grows to 12 inches in height. The leaf bud arrangement is mostly folded. The blade tip is sharply pointed, tapering to the tip. The blade is either flat or folded. The collar is narrow with hairs on the edge; the auricle is absent; the ligule has a fringe of hairs fused at the base; the sheath is slightly flat with tufts of hair at the base of the plant; and the upper ones are rounded and smooth with overlapping margins. The inflorescence is spiked. See Figure 7.1.

Figure 7.1 - Bermudagrass



Zoysia grass - Zoysia grass, Zoysia japonica, is a perennial, warm-season grass spreading stolons and short rhizomes. It is a fine-textured grass, dark in color, and forms a dense turf. It naturally grows to 12 inches in height. The leaf bud arrangement is rolled. The blade tip is short and pointed. The blade is scattered with long hairs and is flat. The collar is indistinct with hairy margins; the auricle is absent; the ligule has a fringe of hairs; and the sheath is round and smooth with hairs at the top and split. The inflorescence is spiked. See Figure 7.2

Perennial ryegrass - Perennial ryegrass, Lolium perenne, is a short-lived, perennial grass with a fibrous root system lacking stolons or rhizomes. It is a medium- to coarse-textured, dark-green grass. It naturally grows to a height of 20 inches. The leaf bud arrangement is

Figure 7.2 - Zoysia Grass

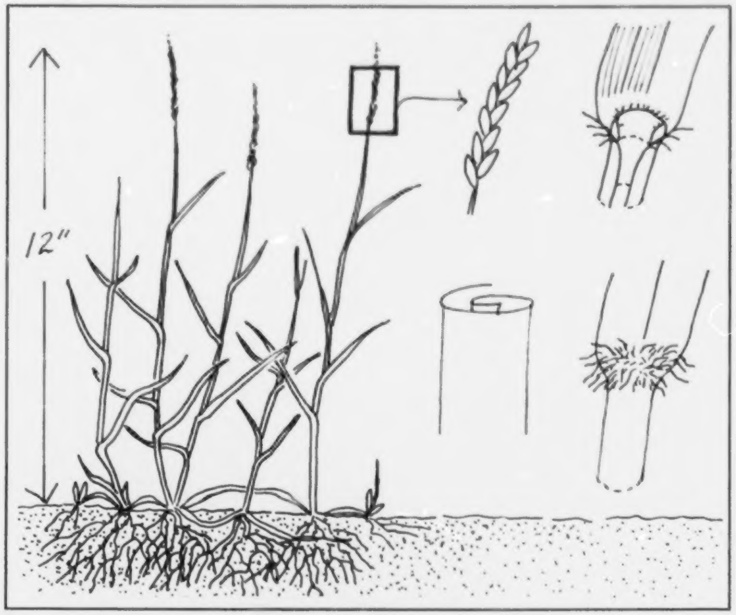
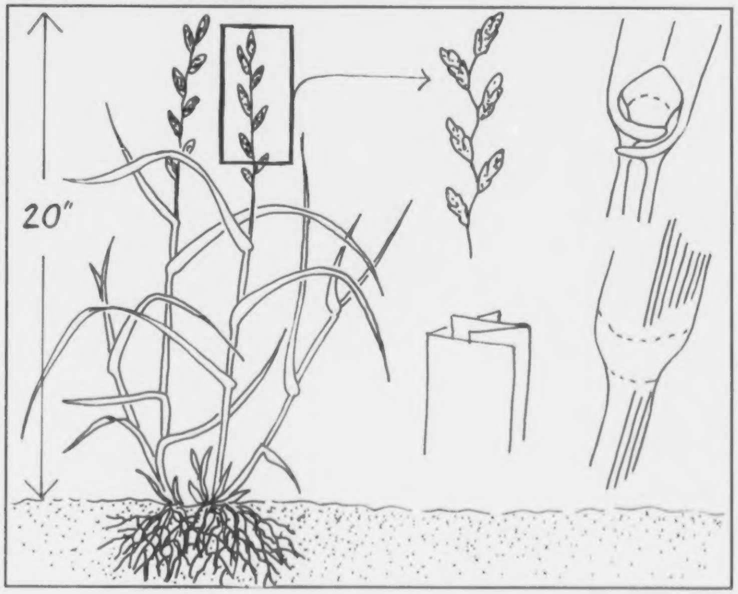


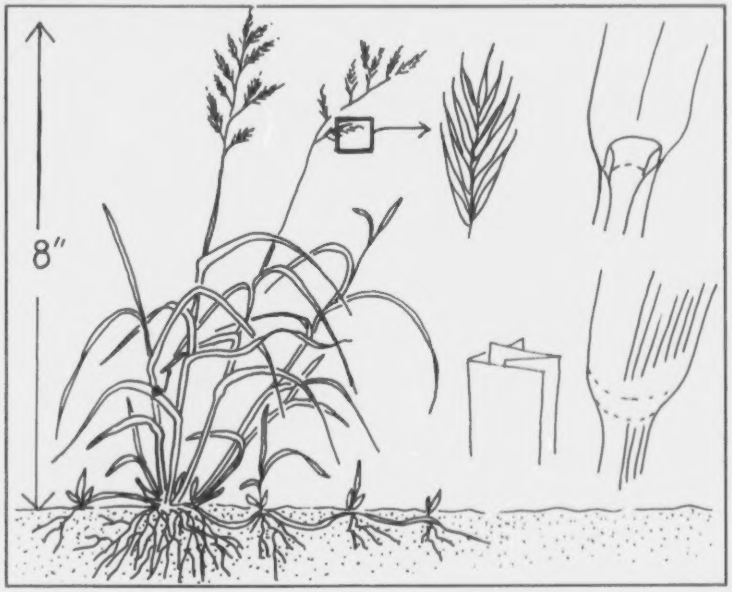
Figure 7.3 - Perennial Ryegrass



folded. The blade is flat, peeled below, and glossy on the bottom. The blade tip is pointed, tapering to the tip; the collar is broad and distinct; the auricle is large and claw-like; the ligule is membranous and entire or it may be toothed, rounded to acute; and the sheath is open, flat, and almost round and smooth. The inflorescence is spiked. See Figure 7.3.

Red Fescue - Red fescue, Festuca rubra, is a cool-season perennial forming bunches. It is a fine-textured, dark-green grass. It naturally grows to 8 inches in height. The leaf bud arrangement is folded. The blade tip is pointed and needle-like. The blade is flat and thick with a thick midrib. The collar is indistinct and narrow; the auricle is absent; the ligule is indistinct, truncate, smooth, and entire; and the sheath is round, smooth, and split. The inflorescence is raceme. See Figure 7.4.

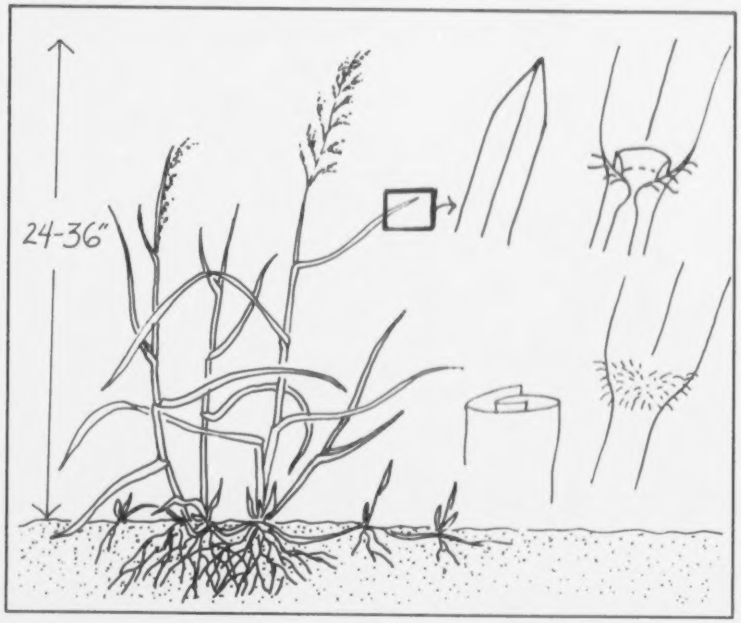
Figure 7.4 - Red Fescue



Tall fescue - Tall fescue, Festuca arundinacae, is a cool-season, perennial grass that spreads by rhizomes and stolons forming bunches. It is a medium- to coarse-textured, medium-green grass that has a tendency to form clumps. It naturally grows to 24-36 inches. The leaf bud arrangement is rolled; the blade tip is parallel-sided; the blade is flat-ridged above and wide; the edges are rough; the collar is hairy, broad, and very distinct; the auricle is blunt to absent with hairs on the margin; the ligule is indistinct and blunt; and the sheath is round, smooth, and split. The inflorescence is raceme. See Figure 7.5.

Kentucky bluegrass - Kentucky bluegrass, Poa pratensis, is a cool-season perennial with slender rhizomes and tillers forming a dense sod. It is medium-textured with a blue-green color. It naturally grows to a height of 12-24 inches. The leaf bud arrangement is folded; the

Figure 7.5 - Tall Fescue



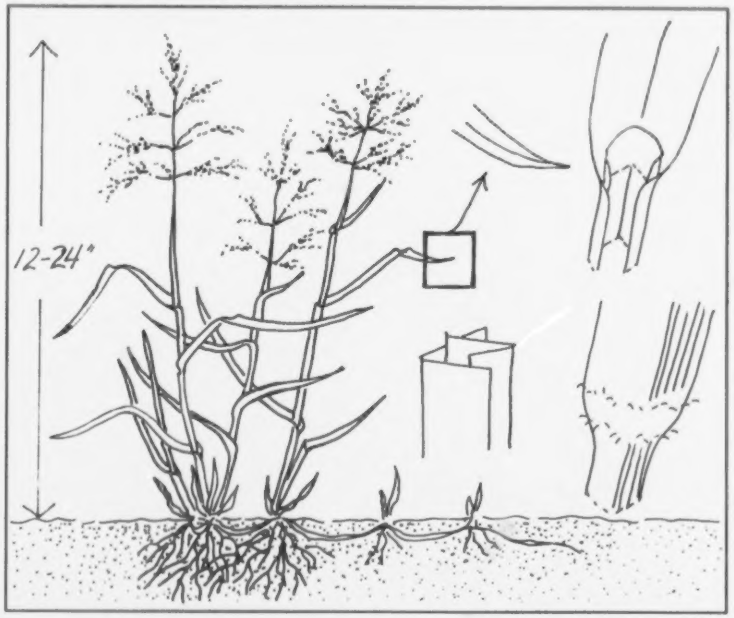
blade tip is boat-shaped and smooth; and the blade is V-shaped with a peeled bottom and smooth. The collar is medium with slight hairs; the auricles are absent; the ligule is membranous, long, truncate, entire, and smooth; and the sheath is smooth and split. The inflorescence is panicle. See Figure 7.6.

Table 7.1 provides identifying characteristics of the six major turfgrasses used in Missouri.

Summary

Since there are six major turfgrasses commonly used in Missouri, it is helpful for the landscaper to know the identifying characteristics of each.

Figure 7.6 - Kentucky Bluegrass



Credits

Diecker, William W. Grass and Grasslike Plants of Cultivated Fields and Pastures, Identified by Vegetative Characteristics. 1st ed. Columbia, MO: UMC - Integrated Pest Management Program, 1980.

Ingles, Jack E. Ornamental Horticulture Principles and Practices. 1st ed. Albany: Delmar Publishing Co., Inc., 1985.

Kucera, Clair K. The Grasses of Missouri. 1st ed. UMC Curators, 1961.

Martin, Edward C., Jr. Landscape Plants in Design. Westport, Connecticut: AVI Publishing Co., Inc., 1983.

TURFGRASSES

Cynodon dactylon - Bermudagrass

Festuca arundinacea - tall fescue

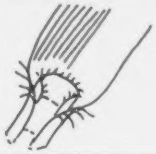
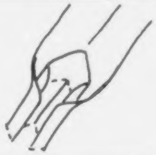
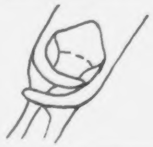
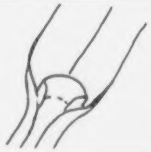
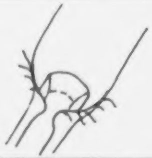
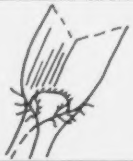
Festuca rubra - red fescue

Lolium perenne - perennial ryegrass

Poa pratensis - Kentucky bluegrass

Zoyzia japonica - zoysia grass

Table 7.1 - Turfgrass Identification

COMMON NAME	BOTANICAL NAME	PICTURE	GROWTH HABIT	TEXTURE	COLOR	NATURAL HEIGHT
Bermudagrass	*Cynodon dactylon*		stolons and rhizomes	fine	dark blue-green	12"
Tall Fescue	*Festuca arundinacea*		rhizomes and stolons	medium to coarse,; forms clumps	medium green	24-36"
Red Fescue	*Festuca rubra*		bunch	fine	dark green	8"
Perennial Ryegrass	*Lolium perenne*		bunch	medium to coarse	dark green	20"
Kentucky Bluegrass	*Poa pratensis*		rhizomes and tillers	medium	blue-green	12-24"
Zoysia Grass	*Zoysia japonica*		stolons and short rhizomes	fine	dark green	12"

494

495

Table 7.1 - Turfgrass Identification continued

BUD LEAF ARRANGEMENT	BLADE TIP	BLADE	COLLAR	AURICLE	LIQULE	SHEATH	INFLORESCENSE
folded	sharply pointed to the tip	flat or folded	narrow with hairs on the edge	absent	fringe of hairs fused at the base	slightly flat with tufts of hair at the base of plant; upper-- rounded, smooth, overlapping	spike
rolled	parallel-sided	flat, ridged above and wide, edges rough	hairy, broad	blunt to absent with hairs on margin	indistinct, blunt	round, smooth, split	racemic
folded	pointed and needle-like	flat with thick midrib, thick	indistinct and narrow	absent	indistinct truncate, smooth, entire	round, smooth, split	racemic
folded	flat keeled below, glossy on bottom	pointed; tapering to tip	broad and distinct	large claw-like	membranous, entire; may be toothed, rounded to acute	open, flat, almost round, smooth	spike
folded	boat-shaped and smooth	v-shaped, reeled, bottom smooth	medium w/slight hairs	absent	membranous, long truncate, entire, smooth	smooth, split	panicle
rolled	short and pointed	flat, scattered with long hairs	indistinct with hairy margins	absent	fringe of hairs	round, smooth with hairs at top, split	spike

Tools are any types of instruments used to do work. They are a vital part of horticulture, particularly in the landscape and turfgrass industries where they are regularly used in the installation and maintenance of plants and grasses.

Tool Identification

Hand tools and equipment are those that are handheld when used. They work well for small jobs and in areas where larger tools cannot fit. There are two main types of hand tools used in landscaping and turfgrass management. These are cutting tools and digging tools. Figure 1.1 illustrates common tools and equipment. Cutting tools are used to cut, chop, and saw. They can also be used to remove, remold, or reshape plants and grasses. Digging tools are used to remove, loosen, turn up, and turn over soil.

Daily Maintenance

Tools are only effective if they are kept in good condition. Besides routine cleaning of tools after use, periodic maintenance will prolong the life of these tools. Without routine maintenance, tools can become dull or rusted. If not well-maintained, tools will need to be professionally repaired, resulting in unnecessary expense. Periodic reconditioning of tools can help prevent this expense. Restoring wood and metal surfaces as well as sharpening tools, are easy methods of maintenance that can be used to keep tools in good working condition.

Restoring wooden handles - When wooden handles are rough, dry, and splintered, they need to be restored. Dry handles should first be sanded, then rubbed with boiled linseed oil using a soft cloth. When the linseed oil becomes dry, rub the handle briskly with another soft cloth.

Restoring metal surfaces - In restoring metal hand tools, the main concern is preventing rust. Rust forms on tools when the metal surface is left wet. The wet metal oxidizes with the air to form rust. The main way of preventing rust is keeping all metal surfaces dry. If hand tools do become rusty, wipe the metal surface with a nonflammable cleaner such as hot, soapy water or naval jelly to remove any grease or oil that may be on them. Gasoline should not be used to clean the metal surface because it is easily vaporized. If the rust has become pitted into the metal, a wire brush or steel wool can be used with the nonflammable cleaner. Silicon carbide paper and oil, such as light, number ten oil, can be used to shine the metal and remove scratches.

Sharpening tools - Tools can be sharpened with files, hand stones, sand stones, bench stones and grinders. The edge of the tool will determine which sharpening device to use. The edge of a tool can have a single or double incline. Examples of tools with a single incline are knives, shears, and saws. These tools are sharp only on one edge. Tools that have a double incline are sharp on two sides, such as knives and axes.

Sharp tools are much safer than dull tools. Less pressure is needed in order to make a cut. A dull tool has a cut but requires more pressure to make a clean cut.

When sharpening tools, remove only enough of the metal to make the tool sharp. Removing too much metal will shorten the life of the tool.

Knives that are serrated should be taken to a repair store for sharpening. Straight edge knives can be sharpened with a grinder. The grinder will remove nicks found on the edge. Knives should be held with the edge up, moving the knife back and forth across the grinder. Next the knife needs to be whetted. Whetting is done on an oiled hand stone, moving the knife edge first across the stone in one direction. The knife is then turned over and moved across the stone in the opposite direction. Whetting makes the edge even and sharp.

Axes and hatchets are sharpened at a 20° angle. The ax or hatchet is moved in a zigzag fashion across a grinding wheel mounted on a belt-driven arbor to remove nicks found in the metal. If a sharper edge is desired, a large file may be used as well. Mower blades need to be

Figure 1.1 - Common Tools and Equipment

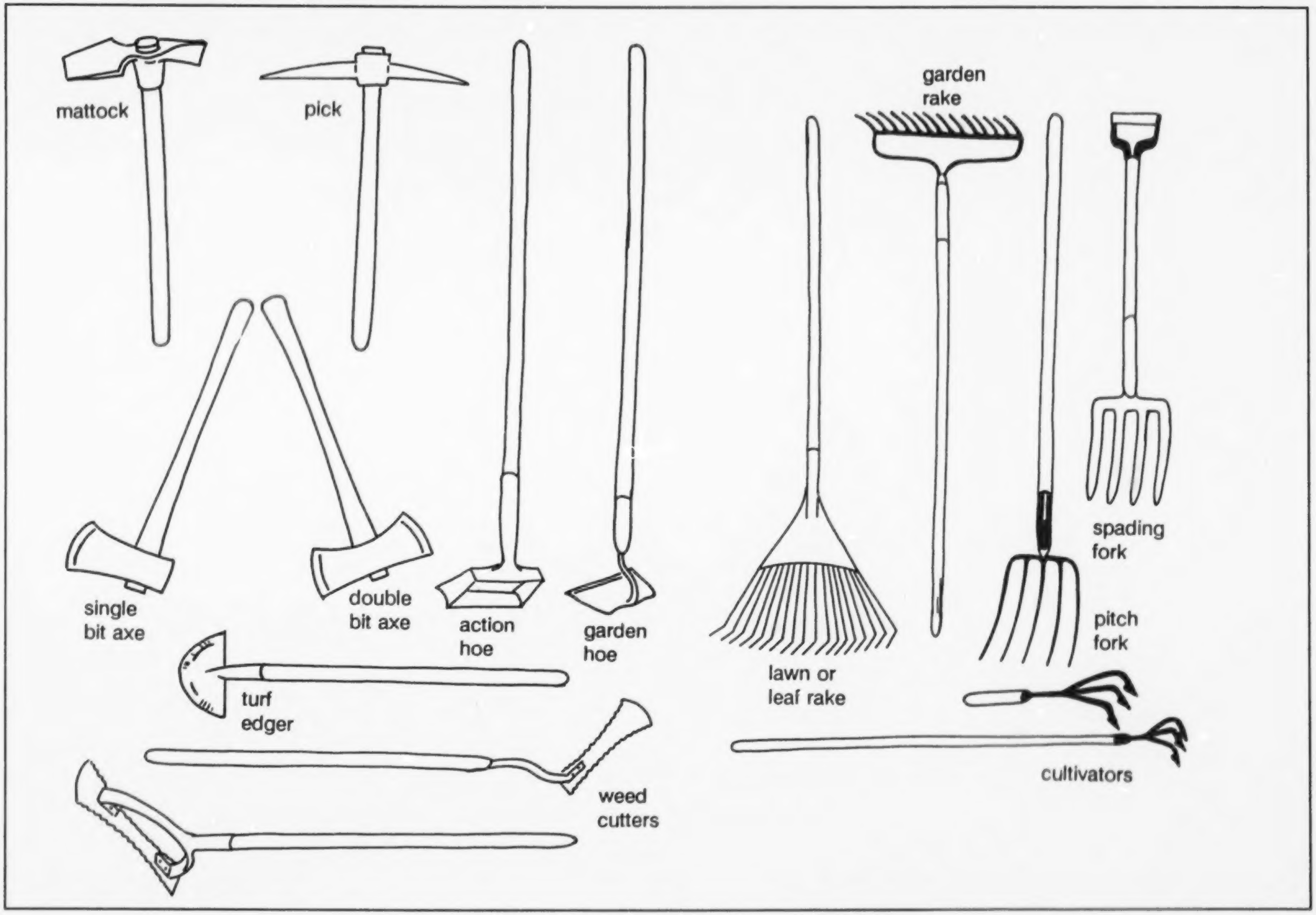
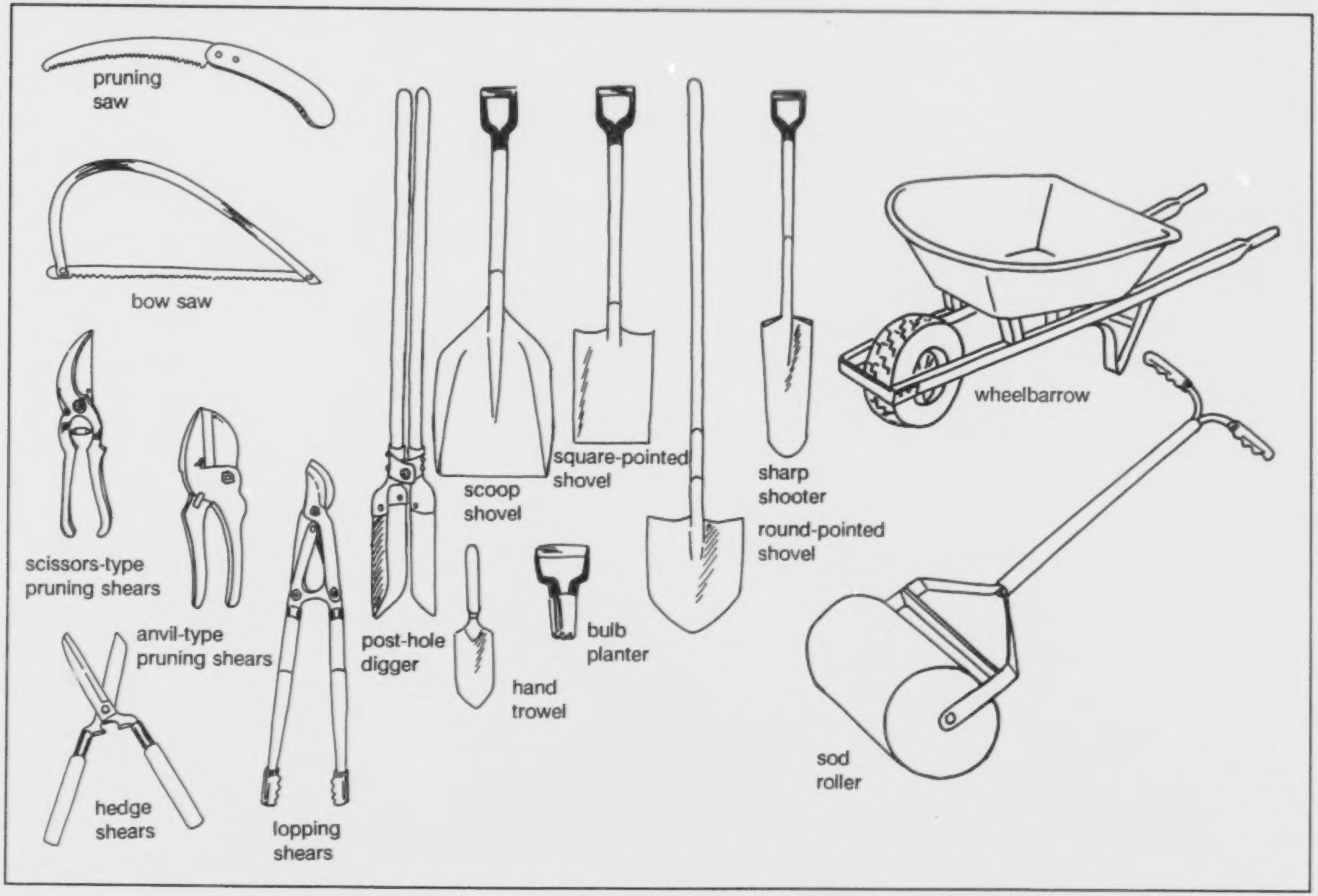

mattock
pick
garden rake
single bit axe
double bit axe
action hoe
garden hoe
spading fork
pitch fork
lawn or leaf rake
turf edger
weed cutters
cultivators

Figure 1.1 - Continued


pruning saw
bow saw
scissors-type pruning shears
anvil-type pruning shears
hedge shears
lopping shears
post-hole digger
scoop shovel
square-pointed shovel
hand trowel
bulb planter
round-pointed shovel
sharp shooter
wheelbarrow
sod roller

sharpened at their original angle. The blade will have a flat edge and a cutting edge. A mower blade needs to be balanced, having the same amount of metal on each side of the center. If a blade is out of balance, it causes vibration throughout the mower which can eventually damage the entire mower. Nicks in the blade can be removed by either filing or grinding. Clamp the blade in a vice and use a large flat file to restore the flat edge side of the blade. The cutting edge is sharpened with a grinder at a 30° to 40° angle. Each flat edge and each cutting edge should have the same number of sharpening strokes in order to maintain balance.

When working with digging tools, sharpen the previously sharp edge. With shovels, the inside edge is sharpened leaving the back edge straight. Digging tools can be sharpened with either a grinder or a file. If the edge has been turned backward, use a steel hammer to reshape the tool before sharpening.

Safety

Safety is important when working with tools. It is best not to wear loose-fitting clothes. Wear eye protection, particularly when sharpening tools. Wear gloves to protect hands. One should always tell another person when and where they are working when working alone. Be conscious of where others are working when using tools, particularly with saws and axes, to prevent any accidents.

Summary

Hand tools and equipment are useful aids in the landscape and turfgrass industries. There are many different types of hand tools and several have a specialized uses. Routine care and maintenance of hand tools and equipment will help prolong their usefulness.

Credits

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Cooper, Elmer L. Agriculture Mechanics: Fundamentals and Applications. Albany, NY: Delmar Publishers Inc., 1987.

Moore, Gary E. and Richardson, William B. Working in Horticulture NY: Gregg Division (McGraw-Hill Book Co.), 1980.

Power tools are tools that operate by using a source of energy such as gasoline or electrical current. They are a big asset to the landscape and turfgrass industries because of allowing these industries to work at larger job sites. Using hand tools at a large job site would be too time-consuming. Power tools can do the work more quickly and economically.

Identification

There are numerous gas and electric powered tools used in the landscape and turfgrass industries. Gas powered tools are more common than electric ones. One reason for this is that at some work sites, a source of electricity may not be available.

Gas - hand-operated tools - The following list includes gas powered tools that are operated by hand.

1. Chain saw
2. Lawn mower
3. Leaf blower/vacuum
4. Rototiller
5. Lawn aerator (core or slicer)
6. String trimmer
7. Edger
8. Hedge trimmers
9. Walk-behind mower
10. Dethatcher
11. Sod cutter
12. Chipper/shredder
13. Trencher
14. Snow blower

Gas - large equipment - Many pieces of large, gas powered equipment are used in the landscape and turfgrass industries. Several are listed here.

1. Tree spade
2. Stump remover
3. Power sweeper
4. Skid loader
5. Front end loader
6. Chipper
7. Snow blade
8. Lawn tractor
9. Fork lift

Electric tools - The following electric tools are sometimes used in the landscape and turfgrass industries.

1. Lawn mower
2. Chain saw
3. Hedge trimmer
4. String trimmer
5. Edger

Maintenance

Maintenance includes the tasks required to keep power tools in good working order. Maintaining power tools extends the usefulness of the tools. There are a number of routine tasks that are important, including checking belts and chains for proper tension before using each tool.

Air cleaners and filters - Checking air cleaners and filters is important in maintenance since they clean dirt and dust from air before it is mixed with fuel. There are three different types of air cleaners and filters: oil foam element, oil bath cleaner, and dry type element. They should be cleaned at least after every 25 hours of operation. When working in extremely dusty conditions, the air cleaners and filters should be cleaned before 25 hours of use. Consult the owner's manual for each power tool for recommended information about maintaining air cleaners and filters.

Crankcase oil - Crankcase oil is important in four-cycle, gasoline engines. Oil helps to lubricate, cool, seal, and clean the engine. Oil should be changed at the beginning of the season before the tool is used. If the tool is used frequently, change the oil after 25 hours of use. It is best to drain the crankcase when the engine is still warm. If the engine is warm, the dirt and carbon which accumulate in the oil, will remain suspended in the oil. Draining the oil at this time helps remove this dirt more effectively.

When the oil has completely drained, replace the plug and refill the crankcase, being careful not to overfill it. If overfilled, the engine crankcase pressure will be higher than normal. If it is too high, oil seals can become damaged causing the engine to use oil excessively. Oil thickness will change with outdoor temperatures. The colder the temperature, the thicker the oil. If the power tool is used in colder temperatures, be sure to check the oil frequently, because thick oil will not travel as easily through the engine parts. The owner's manual for the power tool may indicate to use a lighter weight oil such as 10W30 in winter.

A two-cycle engine does not usually use crankcase oil. Instead, the oil is mixed with the gasoline. Be sure the proper proportion of gasoline and the correct oil type is mixed. Consult owner's manual for each power tool for the recommended oil to use. If the owner's manual has no recommended oil mixture, oil should be mixed 16:1.

Spark plugs - Spark plugs should also be checked and maintained. In general, after 100 hours of use, they should be changed. To maintain spark plugs: scrape off the dirt, soak them in a commercial solvent, and then dry them. The electrodes should be filed to a flat surface and regapped to manufacturer's specifications. Then replace the spark plugs. Consult owner's manual for each power tool for more specific information about spark plugs.

Some power tools only need to be adjusted when problems arise. Other problems may need more then just an adjustment. If this is the case, the power tools may need to be taken to a repair shop for repairs. Report any broken or damaged equipment to the teacher.

Storage

If a power tool is properly stored, it will probably have fewer problems when next used.

When storing a power tool for a month or less follow these steps.

1. Close the fuel valve and drain the carburetor.
2. Fill the tank with gas.
3. Recharge the battery, if needed.

The following steps should be taken when storing power tools for more than a month.

1. Drain the fuel tank and run engine until dry.
2. Change the oil.
3. Clean and replace the filters (e.g.,air,fuel). Most small engine fuel filters are not changed until they plug. The air filter is cleaned and replaced. Follow owner's manual.
4. Clean the exterior of the tool.
5. Loosen belts.
6. Clean and lubricate chains. If one is storing a chain saw, know how to use bar oil.
7. Store power tools off the ground when stored indoors; when stored outdoors, cover the engine to keep it dry.

Safety

Safety is extremely important when working with power tools. Some general safety guidelines are: do not wear loose clothing (it may become entangled in the moving parts of the tool); always work with sharp tools; wear safety goggles to protect eyes; and always let others working nearby know that someone is operating the tool.

When working with gas powered tools, never smoke. Keep hands and feet away from moving parts. Always stop the engine before refilling the gas tank. Keep all safety shields on the tool in the proper places. Use gasoline engines outdoors. If indoor work must be done, operate a ventilation system.

Electric powered tools need to be handled with extreme care. When improperly handled, shock, electrocution, or fire may result. A few safety hints for using electric powered tools are: use only insulated tools; do not work near wet areas; use ground fault circuit interrupters; and do not use cracked extension cords, or ones that feel warm to the touch while in use.

Summary

Power tools can aid in large jobs. There are many power tools, both electric and gas, that can be used. Maintenance of power tools is essential in keeping the tools in good working condition. Checking air filters, changing the crankcase oil, and servicing the spark plugs are three important ways of maintaining power tools. Proper storage of power tools will also help extend the life of the tools. Careful handling of power tools is important for the safety of those using the tools as well as others in the work area.

Credits

Cooper, Elmer L. Agriculture Mechanics: Fundamentals and Applications. Albany, NY: Delmar Publishers, Inc., 1987.

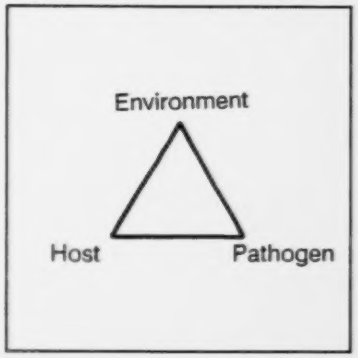
Moore, Gary E. and William B. Richardson. Working in Horticulture. New York, NY: Gregg Division, McGraw-Hill Book Co., 1980.

Pests come in many forms, shapes, and sizes. Some pests are insects, others are diseases, and still others are plants. Having a few pests present on plants is acceptable, but if they start to cause too much damage to plants then the pests must be eliminated. Pesticides are chemicals that are used to control pests.

Disease Triangle

The disease triangle consists of three parts: pathogen, host, and environment. See Figure 1.1. A pathogen can be either a fungus, a bacteria, or a virus. The host is the plant that the pathogen is infesting. The environment would be the weather conditions. All three parts must be present for a disease to grow and become damaging. If any one of the three parts is not present or is not contributing to the growth of a disease, the disease triangle is broken.

Figure 1.1 - Disease Triangle



The most important of the three parts of the disease triangle is the environment. A change in the weather can alter the severity of the disease because each pathogen functions under its own specific range of environmental conditions.

Control of a disease is generally determined by its potential to cause further damage. Some diseases may attack only certain parts of a plant; others may only weaken the plant without destroying it; still others will thrive and then rapidly disappear with a weather change.

Insect Life Cycle

Understanding the life cycle of insects is important in controlling them. Some insects damage plants during each phase of their life cycle, while others damage plants during just one phase of their life cycle. Knowing the stages of an insect's life cycle in which they damage plants will aid in choosing the proper control method. The changes an insect experiences from egg to adult is called metamorphosis. There are four types of metamorphosis in insects.

No metamorphosis - When metamorphosis does not occur, there is no change in the size of the insect, its feeding habits, or its environment. Two examples of insects with no metamorphosis are silverfish and springtail.

Gradual metamorphosis - Gradual metamorphosis occurs in three stages: egg, nymph, and adult. Each phase of the life cycle resembles the other with only gradual changes, such as the development of wings. Feeding habits and environment are the same in each phase. Some examples of insects with gradual metamorphosis are the aphid, scale, and cockroach.

Incomplete metamorphosis - Incomplete metamorphosis also occurs in three stages: egg, naiad, and adult. The young insect is similar to the adult in appearance, but it is aquatic and has different feeding habits and environment. The dragonfly and mayfly are two examples of insects with incomplete metamorphosis.

Complete metamorphosis - Complete metamorphosis occurs in four stages: egg, larva, pupa, and adult. The young insect is entirely different from the adult in appearance, feeding habits, and environment. The pupa is the resting stage where the young insect changes to an adult. Two examples of insects with complete metamorphosis are the beetle and butterfly.

Integrated Pest Management

A good horticulturist will use an Integrated Pest Management program to control pests. Integrated Pest Management is the combination of cultural, biological, mechanical, and chemical pest control methods. Cultural pest control uses cultural practices to interrupt a stage in the life cycle of pests. Some cultural control practices might be sanitation, mowing, and watering. Biological pest control is the use of natural enemies on pests. For example, the ladybug is a helpful insect in the garden because it feeds on aphids. The use of any specialized equipment, such as an electric bug zapper, is a means of mechanical pest control. Chemical pest control is the use of one or more types of pesticides.

Pesticides are not the only source of control for diseases. Plants are genetically bred for susceptibility, tolerance, resistance, or immunity to specific diseases.

Integrated Pest Management is gaining popularity over the use of pesticides. Pesticides can cause damage to the environment, kill animals, and some are extremely toxic to humans. In addition, pesticides are expensive and repeated applications are often necessary in order for them to be effective. Some pests are becoming immune to pesticides because of continued use.

To have an effective Integrated Pest Management program, it must be determined whether there is enough damage to the plants to justify control. If so, cultural, biological, mechanical, or a combination of controls should be used. As a last resort, pesticides can be applied.

Origin of Pesticides

People have been using some types of pesticides to control pests throughout history.

Inorganic pesticides - The first types of pesticides used were inorganic. These pesticides were made from minerals; such as arsenic, lead, or sulfur, and acted as stomach poisons. Inorganic pesticides can be harmful to humans; therefore, today, inorganic pesticides are used infrequently.

Organic pesticides - Organic pesticides are another type. They are made from plant material and are generally safer to humans than inorganic pesticides. Organic pesticides are used primarily as stomach or contact poisons.

Synthetic pesticides - Pesticides that are not natural, but are manufactured through various chemical combinations, are called synthetic pesticides.

All pesticides are intended to kill living things. They should be used with extreme caution in all situations.

Types of Pesticides

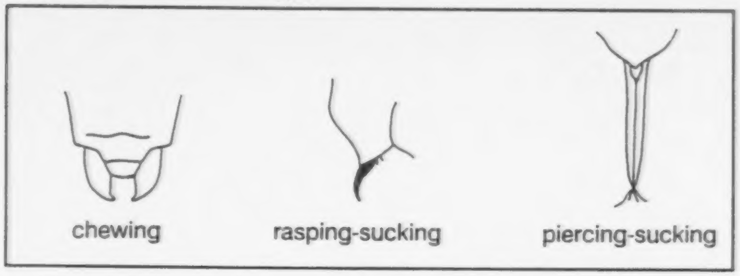
There are many different types of pests. Not all pests are insects. Other types of pests include weeds, diseases, spiders, slugs, mice, and nematodes. Each type of pest requires a specific type of pesticide. See Table 1.1 There are four ways in which pesticides work: as stomach poisons, systemic poisons, contact poisons, and fumigants.

Table 1.1 - Pesticide, Target Pest, and Killing Method

Type of Pesticide	Pest	Kills by
Insecticide	Insects	Eating, Swallowing, or Contacting
Herbicide	Weeds	
a) selective	a) broad-leaf plants	Contacting
	b) narrow-leaf plants	Contacting
b) nonselective	All Plants	Contacting
Fungicide	Fungi	Contacting
Bactericide	Bacteria	Contacting
Miticide	Mites	Contacting
Aracicide	Spiders, Ticks, Mites	Contacting
Rodenticide	Mice, Rats, Moles	Eating, Swallowing
Molluscicide	Snails, Slugs	Eating, Swallowing
Nematocide	Nematodes	Inhaling

Types of mouth parts - It is also important to consider how an insect feeds on a plant when searching for an effective pesticide. There are three types of mouth parts that an insect can have: chewing, rasping-sucking, or piercing-sucking. See Figure 1.2. An insect with a chewing

Figure 1.2 - Mouth Part Types



mouth part will actually bite a piece of the plant off and chew it. A rasping-sucking insect will bite the plant making a cut and then suck the juices from the plant. A piercing-sucking insect will pierce a small hole into the plant and suck the sap out of the plant. Table 1.2 lists mouth types for several insects.

Table 1.2 - Insects with Different Types of Mouth Parts

Chewing	Rasping-Sucking	Piercing-Sucking
Grasshopper	Thrip	Aphid
Grub	Whitefly	
Cutworm	Leaf bug	
Caterpillar	Spider mite	
Beetle	Nematode	

How Pesticides Work

Pests can be either plants or animals. If they are animals they may have different life cycles or mouth parts; therefore, different pesticides may be more effective than others. Some pests need to eat the pesticide, others must come in physical contact with the pesticide, and still others must inhale the pesticide. See Table 1.3.

Table 1.3 - How Pesticides Work

Type of Poison	Application	Action	Mouth Type
Stomach	Spray or dust on plant	Must be eaten	Chewing
Systemic	Soil drench, or spray which is absorbed by plant, not harmful to plant	Eaten or swallowed	Chewing, piercing-sucking, rasping-sucking
Contact	Spray or dust	Must touch pest	not important
Fumigant	Spray as a gas	Vapors must be inhaled	not important

Pesticide Formulations

Pesticides come in two different forms and can be applied in various ways. The two main forms are liquid and dry. Both liquid and dry pesticides each have five different types of formulations.

Pesticide formulations can be applied to plants with sprayers, dusters, or spreaders. A liquid form of a pesticides is applied with a sprayer. There are many kinds of sprayers. A duster is used to apply dust forms of pesticides. Spreaders are used to apply granular forms of pesticides. See Table 1.4.

Summary

Integrated Pest Management, which is a combination of cultural, biological, mechanical, and chemical controls, is a preferred method of pest control. At times, the only effective pest control method is chemical pesticides. Understanding the disease triangle and the life cycle of insects aids in the effective use of pesticides. Each type of pest requires a specific type of pesticide. These pesticides are

Table 1.4 - Pesticide Formulations

Form	Formulation	Letter of Formulation	Description
Liquid	Emulsifiable concentrates	EC or C	Liquid which is mixed with water
	Solutions	S	Liquid which does not require diluting with water
	Flowables	FL or L	Thick liquid which must be mixed with water
	Aerosols	A	Liquid in pressurized can which is released as a mist
	Liquid gas	no letter	Liquid changing to gas or vapor when released
Dry	Dusts	D	Fine powder mixed with inactive material
	Granules	G	Small pellets
	Wettable powder	WP	Fine powder which is mixed with water; does not dissolve in water
	Soluble powders	SP	Fine powder which is mixed with water, dissolves in water
	Baits	B	Edible or attractive material

effective as stomach poisons, systemic poisons, contact poisons, or fumigants. All pesticides are classified as either organic, inorganic, or synthetic pesticides; and come in liquid or dry forms.

Credits

Moore, Gary E.; William B. Richardson. Working in Horticulture. New York, NY: Gregg Division (McGraw-Hill Book Co.,) 1980.

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Reiley, H. Edward; Carroll L. Shry, Jr. Introductory Horticulture. Albany, NY: Delmar Publishers, Inc., 1988.

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"Understanding and Using Garden and Home Grounds Herbicides" (GO6951), University Extension: University of Missouri-Columbia.

There are various types of pesticides including insecticides, herbicides, and rodenticides. Each type has specific ingredients, method of application, and pests it will control. Some pesticides cannot be applied on certain plants; others can be applied on a variety of plants. This, as well as additional information, can be found on the label of a pesticide container. See Figure 2.1 on next page.

Names of Pesticides

Just as all plants have two names, common and botanical, pesticides have more than one as well. Pesticides have three names; a brand or trade name, a common name, and a chemical name. A brand or trade name is the name given to a pesticide by the manufacturing or packaging company. This name is used in advertising. Each brand name will have a trademark symbol • behind its name. The Environmental Protection Agency (EPA) also creates a name for identification of the pesticide. This is the common name. For example, Lorsban• and Durban• are Chlorphyrifos, which is an insecticide. The chemical name is originated from the chemical structure of the pesticide.

The EPA has classified pesticides into two categories, general-use pesticides and restricted-use pesticides. Anyone can purchase a general-use pesticide. These pesticides are not likely to harm humans, animals, or the environment when used according to label instructions. The restricted-use pesticides can only be purchased and applied by certified applicators; because they are extremely dangerous to humans, animals, and the environment.

Degrees of Toxicity

For the protection of humans, animals, and the environment; the EPA has made rules and set standards concerning pesticides. There are two different degrees of toxicity measured according to the amount of poison in the pesticide. They are acute and chronic.

Acute toxicity - Acute toxicity is when poisoning occurs by either inhaling, ingesting, or contacting the pesticide. It usually happens when a pesticide is accidentally splashed in the mouth, or a spill occurs on the clothing or body of the applicator.

Chronic toxicity - Chronic toxicity is poisoning that results from repeated exposure to a pesticide over a period of time. Chronic poisoning is caused from applying pesticides repeatedly without wearing protective clothing, or cleaning clothes or equipment inadequately after using pesticides. Poisoning can occur orally, dermally (through the skin), and by inhalation.

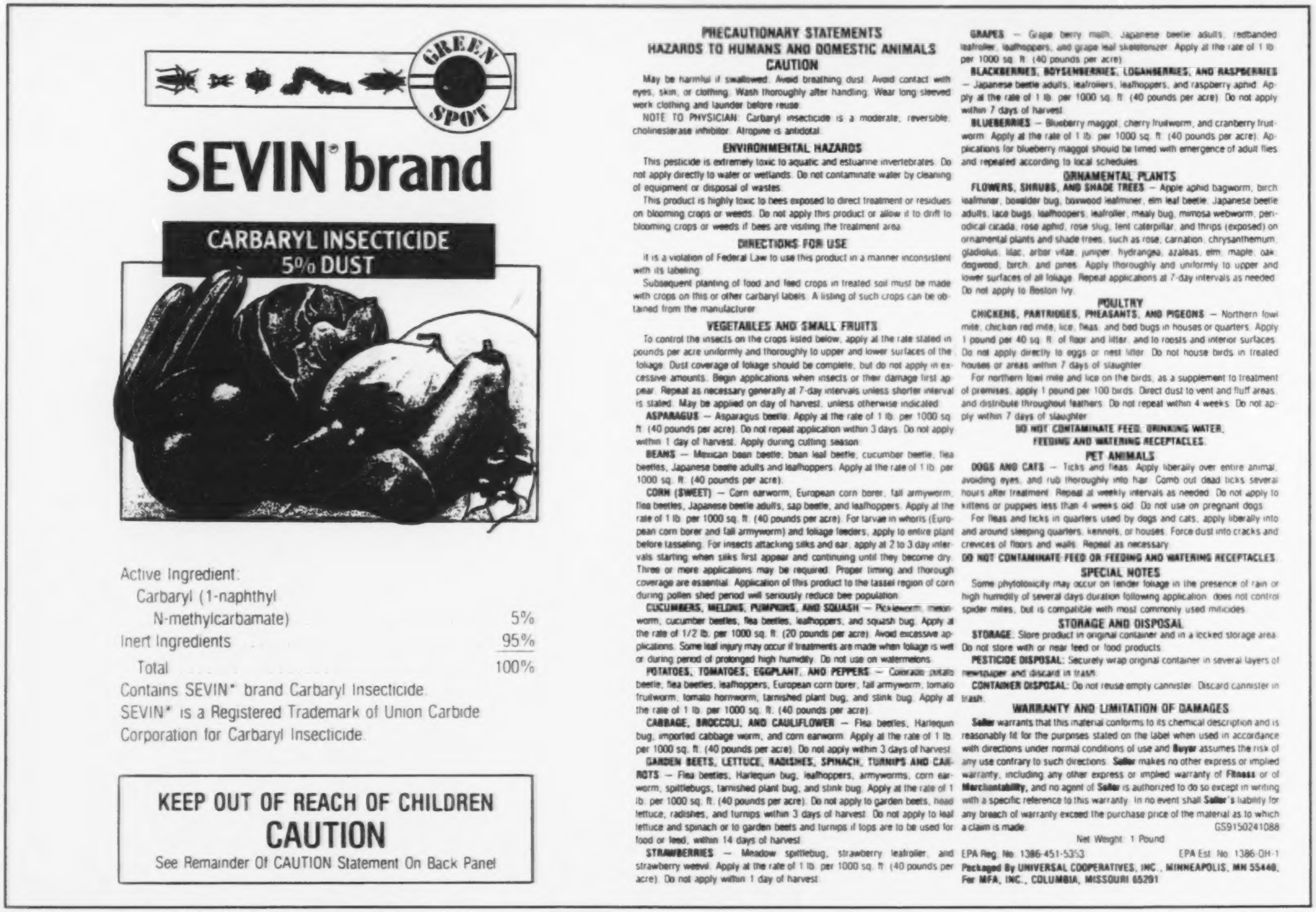
Signal Words

There are three important words on the pesticide label which signify the degree of severity of the poison. These words are normally capitalized and in bold print. The three words are DANGER, WARNING, and CAUTION. The word DANGER, accompanied by the symbol of a skull and crossbones, is usually printed in red. DANGER means that the pesticide is highly toxic. It could take approximately one teaspoon to kill an average person. WARNING is defined as

Table 2.1 - Common Hazard Statements Following Signal Words

DANGER	WARNING	CAUTION
Fatal if swallowed	Harmful or fatal if swallowed	Harmful if swallowed
Poisonous if inhaled		May be harmful if absorbed through skin
Extremely hazardous if skin contact occurs	Harmful or fatal if absorbed through skin	
Corrosive (causes eye damage)	Harmful or fatal if inhaled	May irritate eyes, nose, throat, and skin
Causes severe skin burns	Causes skin and eye irritation	

Figure 2.1 - Sample Pesticide Label



GREEN SPOT

SEVIN® brand

CARBARYL INSECTICIDE
5% DUST

Active Ingredient:	
Carbaryl (1-naphthyl N-methylcarbamate)	5%
Inert Ingredients	95%
Total	100%

Contains SEVIN® brand Carbaryl Insecticide.
SEVIN® is a Registered Trademark of Union Carbide Corporation for Carbaryl Insecticide.

KEEP OUT OF REACH OF CHILDREN
CAUTION
See Remainder Of CAUTION Statement On Back Panel

PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS AND DOMESTIC ANIMALS
CAUTION

May be harmful if swallowed. Avoid breathing dust. Avoid contact with eyes, skin, or clothing. Wash thoroughly after handling. Wear long sleeved work clothing and launder before reuse.

NOTE TO PHYSICIAN: Carbaryl insecticide is a moderate, reversible, cholinesterase inhibitor. Atropine is antidotal.

ENVIRONMENTAL HAZARDS

This pesticide is extremely toxic to aquatic and estuarine invertebrates. Do not apply directly to water or wetlands. Do not contaminate water by cleaning of equipment or disposal of wastes.

This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.

DIRECTIONS FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.

Subsequent planting of food and feed crops in treated soil must be made with crops on this or other carbaryl labels. A listing of such crops can be obtained from the manufacturer.

VEGETABLES AND SMALL FRUITS

To control the insects on the crops listed below, apply at the rate stated in pounds per acre uniformly and thoroughly to upper and lower surfaces of the foliage. Dust coverage of foliage should be complete, but do not apply in excessive amounts. Begin applications when insects or their damage first appear. Repeat as necessary generally at 7-day intervals unless shorter interval is stated. May be applied on day of harvest, unless otherwise indicated.

ASPARAGUS — Asparagus beetle. Apply at the rate of 1 lb. per 1000 sq. ft. (40 pounds per acre). Do not repeat application within 3 days. Do not apply within 1 day of harvest. Apply during cutting season.

BEANS — Mexican bean beetle, bean leaf beetle, cucumber beetle, flea beetles, Japanese beetle adults and leafhoppers. Apply at the rate of 1 lb. per 1000 sq. ft. (40 pounds per acre).

CORN (SWEET) — Corn earworm, European corn borer, fall armyworm, flea beetles, Japanese beetle adults, sap beetle, and leafhoppers. Apply at the rate of 1 lb. per 1000 sq. ft. (40 pounds per acre). For larvae in whorls (European corn borer and fall armyworm) and foliage feeders, apply to entire plant before tasseling. For insects attacking silks and ear, apply at 2 to 3 day intervals starting when silks first appear and continuing until they become dry. Three or more applications may be required. Proper timing and thorough coverage are essential. Application of this product to the tassel region of corn during pollen shed period will seriously reduce bee population.

CUCUMBERS, MELONS, PUMPKINS, AND SQUASH — Pickleworm, melonworm, cucumber beetles, flea beetles, leafhoppers, and squash bug. Apply at the rate of 1/2 lb. per 1000 sq. ft. (20 pounds per acre). Avoid excessive applications. Some leaf injury may occur if treatments are made when foliage is wet or during period of prolonged high humidity. Do not use on watermelons.

POTATOES, TOMATOES, EGGPLANT, AND PEPPERS — Colorado potato beetle, flea beetles, leafhoppers, European corn borer, fall armyworm, tomato fruitworm, tomato hornworm, tarnished plant bug, and stink bug. Apply at the rate of 1 lb. per 1000 sq. ft. (40 pounds per acre).

CABBAGE, BROCCOLI, AND CAULIFLOWER — Flea beetles, Harlequin bug, imported cabbage worm, and corn earworm. Apply at the rate of 1 lb. per 1000 sq. ft. (40 pounds per acre). Do not apply within 3 days of harvest.

GARDEN BEETS, LETTUCE, RADISHES, SPINACH, TURNIPS AND CARROTS — Flea beetles, Harlequin bug, leafhoppers, armyworms, corn earworm, spittlebugs, tarnished plant bug, and stink bug. Apply at the rate of 1 lb. per 1000 sq. ft. (40 pounds per acre). Do not apply to garden beets, head lettuce, radishes, and turnips within 3 days of harvest. Do not apply to leaf lettuce and spinach or to garden beets and turnips if tops are to be used for food or feed, within 14 days of harvest.

STRAWBERRIES — Meadow spittlebug, strawberry leafroller, and strawberry weevil. Apply at the rate of 1 lb. per 1000 sq. ft. (40 pounds per acre). Do not apply within 1 day of harvest.

GRAPES — Grape berry moth, Japanese beetle adults, redbanded leafroller, leafhoppers, and grape leaf skeletonizer. Apply at the rate of 1 lb. per 1000 sq. ft. (40 pounds per acre).

BLACKBERRIES, BOYSENBERRIES, LOGANBERRIES, AND RASPBERRIES — Japanese beetle adults, leafrollers, leafhoppers, and raspberry aphid. Apply at the rate of 1 lb. per 1000 sq. ft. (40 pounds per acre). Do not apply within 7 days of harvest.

BLUEBERRIES — Blueberry maggot, cherry fruitworm, and cranberry fruitworm. Apply at the rate of 1 lb. per 1000 sq. ft. (40 pounds per acre). Applications for blueberry maggot should be timed with emergence of adult flies and repeated according to local schedules.

ORNAMENTAL PLANTS

FLOWERS, SHRUBS, AND SHADE TREES — Apple aphid bagworm, birch leafminer, boxelder bug, boxwood leafminer, elm leaf beetle, Japanese beetle adults, lace bugs, leafhoppers, leafroller, mealy bug, mimosa webworm, periodical cicada, rose aphid, rose slug, tent caterpillar, and thrips (exposed) on ornamental plants and shade trees, such as rose, carnation, chrysanthemum, gladiolus, lilac, arbor vitae, juniper, hydrangea, azaleas, elm, maple, oak, dogwood, birch, and pines. Apply thoroughly and uniformly to upper and lower surfaces of all foliage. Repeat applications at 7-day intervals as needed. Do not apply to Boston Ivy.

POULTRY

CHICKENS, PARTRIDGES, PHEASANTS, AND PIGEONS — Northern fowl mite, chicken red mite, lice, fleas, and bed bugs in houses or quarters. Apply 1 pound per 40 sq. ft. of floor and litter, and to roosts and interior surfaces. Do not apply directly to eggs or nest litter. Do not house birds in treated houses or areas within 7 days of slaughter.

For northern fowl mite and lice on the birds, as a supplement to treatment of premises, apply 1 pound per 100 birds. Direct dust to vent and fluff areas, and distribute throughout feathers. Do not repeat within 4 weeks. Do not apply within 7 days of slaughter.

DO NOT CONTAMINATE FEED, DRINKING WATER,
FEEDING AND WATERING RECEPTACLES.

PET ANIMALS

DOGS AND CATS — Ticks and fleas. Apply liberally over entire animal, avoiding eyes, and rub thoroughly into hair. Comb out dead ticks several hours after treatment. Repeat at weekly intervals as needed. Do not apply to kittens or puppies less than 4 weeks old. Do not use on pregnant dogs.

For fleas and ticks in quarters used by dogs and cats, apply liberally into and around sleeping quarters, kennels, or houses. Force dust into cracks and crevices of floors and walls. Repeat as necessary.

DO NOT CONTAMINATE FEED OR FEEDING AND WATERING RECEPTACLES.

SPECIAL NOTES

Some phytotoxicity may occur on tender foliage in the presence of rain or high humidity of several days duration following application. does not control spider mites, but is compatible with most commonly used miticides.

STORAGE AND DISPOSAL

STORAGE: Store product in original container and in a locked storage area. Do not store with or near feed or food products.

PESTICIDE DISPOSAL: Securely wrap original container in several layers of newspaper and discard in trash.

CONTAINER DISPOSAL: Do not reuse empty cannister. Discard cannister in trash.

WARRANTY AND LIMITATION OF DAMAGES

Seller warrants that this material conforms to its chemical description and is reasonably fit for the purposes stated on the label when used in accordance with directions under normal conditions of use and **Buyer** assumes the risk of any use contrary to such directions. **Seller** makes no other express or implied warranty, including any other express or implied warranty of **Fitness** or of **Merchantability**, and no agent of **Seller** is authorized to do so except in writing with a specific reference to this warranty. In no event shall **Seller**'s liability for any breach of warranty exceed the purchase price of the material as to which a claim is made.

GS9150241088

Net Weight: 1 Pound

EPA Reg. No. 1386-451-5353
EPA Est. No. 1386-OH-1

Packaged By UNIVERSAL COOPERATIVES, INC., MINNEAPOLIS, MN 55440,
For MFA, INC., COLUMBIA, MISSOURI 65201

Courtesy of MFA, INC., Columbia, MO. 65201.

BEST COPY AVAILABLE

moderately toxic. It would take anywhere from one teaspoon to one tablespoon to kill an average person. CAUTION means low toxicity. It would take from one ounce to one pint to kill an average person. These three signal words are generally followed by a hazard statement. These statements may vary, as illustrated in Table 2.1.

Other Information

A pesticide label contains other information, as well. Some other information frequently found on a pesticide label follows.

1. Name and address of manufacturer
2. Active ingredients and net content
3. Type and formulation of pesticide
4. EPA registration and identification number
5. Directions for use (e.g. how to use, pests it will control, where to apply it, when to apply it, and plants it is intended to protect)
6. Hazard statement
7. Precaution statement (It suggests protective clothing. May state such cautions as; keep away from heat, do not use on windy days.)
8. Misuse statement (This states it is against federal law to use any pesticide incorrectly, at an unrecommended rate, or on plants or pests not suggested on label.)
9. Statement of practical treatment (This suggests how to give first aid.)
10. Storage and disposal instructions
11. Reentry and safe handling of plant

Summary

Reading the label of a pesticide will provide essential information about the pesticide. Three names: the brand or trade, common, and chemical can be found on the label. Pesticides are classified as general-use or restricted-use depending on their degree of toxicity. These toxicities may be either acute or chronic. The signal words DANGER, WARNING, or CAUTION are also found on pesticide labels. Additional information may include ingredients, EPA identification number, directions, and storage recommendations.

Credits

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Applying Pesticides Correctly: A Guide for Private and Commercial Applicators. North Carolina State University in Cooperation with Extension Service and the United States Department of Agriculture. United States Department of Agriculture and Environmental Protection Agency.

Because there are no safe pesticides, safety is absolutely necessary in handling them. Each pesticide is different in toxicity level and poisoning effects; therefore each requires specific safety precautions which are printed on the label. The label on a pesticide container has important information about the safe handling of the pesticide; therefore, always read the label first.

Mixing and Applying Pesticides

Not all pesticides are ready for direct application from the container. In fact, most have to be mixed with another substance. A few safety rules to follow when mixing pesticides are listed below.

1. Read and follow directions on the label before mixing any pesticide.
2. Always wear protective clothing.
3. Hold pesticide, container, and equipment below eye level to prevent splashing the substance into the eyes.
4. Use a separate set of measuring utensils just for pesticide use. (Do not use the same set for food preparation.)
5. Never mix a pesticide with another pesticide unless it is recommended on the label.
6. Work in a well-ventilated area with good lighting.
7. Never use more than the recommended rates.
8. Mix only the amount of pesticide that will be needed.
9. Measure carefully.

Once the pesticide is mixed safely and correctly, it is also essential to apply it safely, as well. Rules for safe application of pesticides follow.

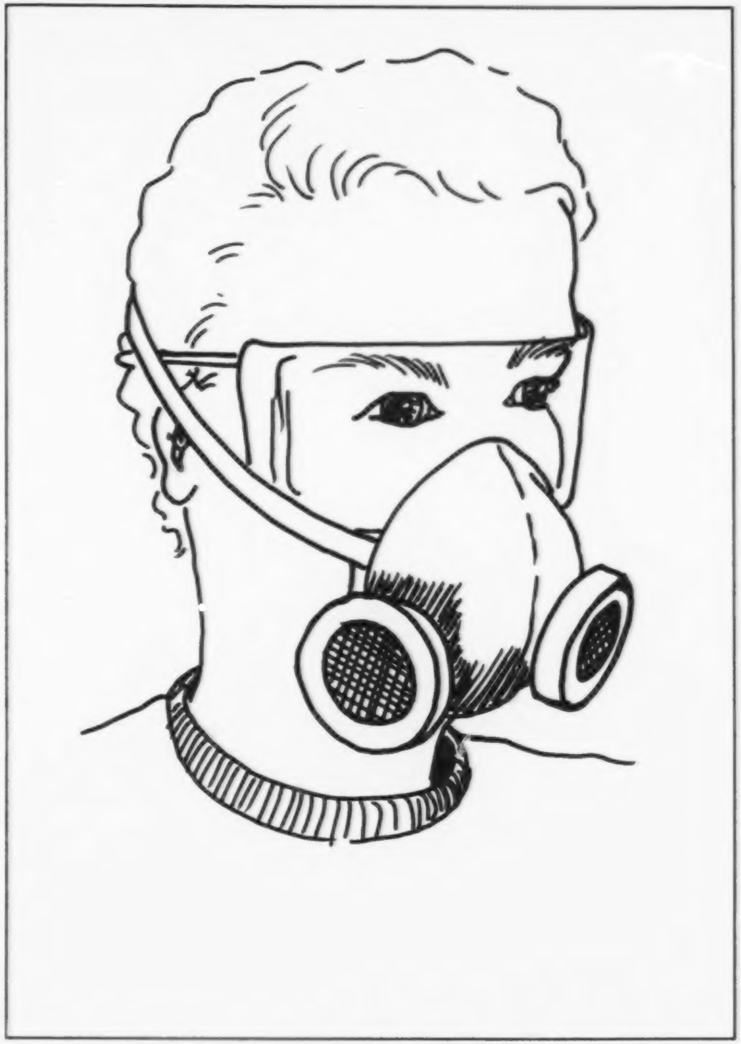
1. Read and follow the directions on the label.
2. Apply pesticides only on pests and plants that are recommended on the label.
3. Wear protective clothing.
4. Never smoke or eat when using pesticides.
5. Apply carefully, directing the pesticide only at the area to be sprayed.
6. Do not spray pesticides on a windy or rainy day. Wind may cause the pesticide to drift where it is not intended. Also, spray downwind. Rain will dilute the pesticide concentration.
7. When using highly toxic pesticides, do not work alone. That way, if poisoning should occur, someone is there to help.
8. Always wash after applying pesticides. Taking a shower is preferable to tub-bathing. Wash hair and scrub hands to remove residue left under fingernails. Wash pesticide-laden clothing separately from everyday clothing. Wash equipment by flushing it thoroughly with water.

Special Clothing and Equipment

Wearing protective clothing when applying pesticides will help reduce the chance of poisoning. A long sleeved shirt, long pants, and rubber gloves that cover wrists should be worn. These gloves should not be lined with cotton because the lining may absorb some of the pesticide. Gloves should be worn inside the shirt sleeve to prevent pesticide from running down the arms. A head covering of some sort should be worn; preferably a wide-brimmed, waterproof hat made of plastic. The hat will help protect neck and face from contamination. Wear unlined rubber boots to protect the feet. Pant legs should be worn on the outside of the boots to keep the pesticide from running into the boots. Safety goggles or a face shield should be worn for eye protection. Waterproof clothing, such as a raincoat, should also be worn.

Since pesticides can be quickly absorbed into the lungs, a respirator should be used. A respirator can be any variety of specialized equipment that is placed over the mouth and nose to prevent the applicator from breathing in the pesticide. A respirator will filter out the harmful poison. Some respirators may also be hooked up to an oxygen supply. Again, always read and follow the pesticide label for instructions on special protective clothing and equipment that should be used during the application of the pesticide. See Figure 3.1.

Figure 3.1 - Respirator



First Aid

Since the amount of time elapsing between the pesticide poisoning and getting to the doctor may make the difference between life and death for the poisoning victim, ALWAYS ACT IMMEDIATELY. Without endangering oneself, remove the victim from the contaminated area. Remove contaminated clothing from the victim. In order to protect oneself from contamination, wear protective clothing and/or equipment. Contact the Poison Control Center or a doctor and administer first aid procedures as indicated.

Storing and Disposing of Pesticides

Pesticides and their containers must be stored and disposed of properly. Store pesticides in their original containers in a locked cabinet or room away from children, irresponsible adults, and animals. The area where the pesticides are stored should be cool, dry, lighted, and well-ventilated. Place signs stating "DANGER-POISONS" in plain sight. If a container leaks or is damaged, store the pesticide in another, properly-labeled container which holds that exact pesticide. To reduce the chance of a mix-up, never use food or drink containers.

Try to mix the correct amount of pesticide solution for each application to avoid the need to dispose of the excess amount. Excess prepared pesticides must be disposed of safely to avoid harming people, animals, or the environment. First, carefully read and follow pesticide container label instructions for precautions and/or disposal methods. If additional areas have the same pest problem, apply the surplus pesticide on those areas as well. If this is impossible, then take the excess pesticide and/or pesticide containers to a landfill operating under a supplemental permit allowing for toxic waste disposal. The same should be done for outdated or unwanted pesticides. Note that a great majority of solid waste landfills lack a supplemental permit and, consequently, are not legally able to handle pesticides. Never flush pesticides down the drain or into sewers.

Do not leave pesticides or pesticide containers at the application site. Never reuse pesticide containers. Keep all pesticide containers out of the reach of children. Leftover pesticides should be kept in tightly closed containers in a storage facility. The U.S. Department of Agriculture and the U.S. Environmental Protection Agency has set up specific guidelines for pesticide disposal. The State of Missouri Department of Natural Resources can help with problems concerning the safe disposal of pesticides and pesticide containers. The address and phone numbers follow:

Missouri Department of Natural Resources
Division of Environmental Quality
P.O. Box 176
Jefferson City, MO 65102
Business phone: (314)751-7929
Emergency response phone: (314)634-2436

Summary

Pesticide safety is essential in the prevention of poisonings. Special rules apply in the mixing and application of pesticides; therefore, it is important to read the label first before handling any pesticide. Protective clothing should always be worn when mixing and applying pesticides. If poisoning occurs, contact a physician and begin administering first aid. Pesticides should be stored and disposed of properly.

The local fire chief and police department should be notified that pesticides are stored in buildings. They need to know the types of pesticides and the location where they are stored. This is important for them to know because what appears to be smoke is sometimes not just smoke. Chemicals may actually be in the smoke. If this is the case, the fire department needs to know what chemicals are present so they know how to safely contain the fire.

Credits

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G07500: Safe Use of Insecticides
G01915: First Aid for Pesticide Poisoning
G01916: Pesticide Application Safety
G01917: Personal Protective Equipment for Working with Pesticides

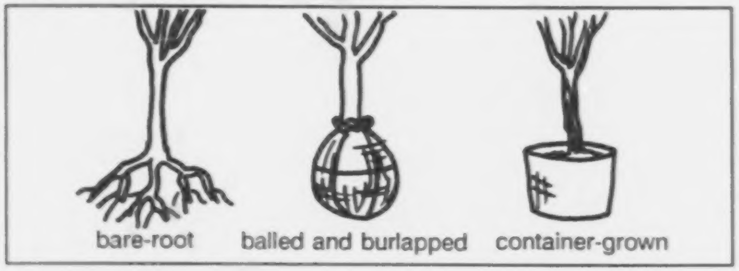
Introduction

When working with a landscape company, landscapers may be confronted with planting many different forms of trees and shrubs. Employers will expect landscapers to be knowledgeable about each one. Landscapers should be aware of proper procedures and what the consequences will be if they do not follow them. A mistake could cost the life of the tree.

How Trees and Shrubs are Sold

Plants are sold in three ways: bare-root; balled and burlapped (B and B); or container-grown. See Figure 1.1.

Figure 1.1 - Ways Plants are Sold



Bare-root plants - Bare-root plants are comparatively inexpensive compared to B and B or container-grown plants. They are lightweight and easy to transplant. They should be dormant, at the time of transplanting, in the winter or early spring. A big advantage is that the same soil dug from the hole can be used as back-fill. There is no other soil, so a transition zone is not needed.

Some disadvantages of bare-root plants are that there is a reduced root system and the plants are usually small, requiring more time to mature. The transplant season is limited to winter, for some, and early spring.

Balled and burlapped plants - Balled and burlapped plants, referred to as B and B, are plants dug with a ball of soil containing its roots and wrapped in burlap. With B and B, larger plants can be transplanted with less damage to the root system, or shock to the plant. They can be planted throughout the early spring and late fall. Plants can be planted in the winter as long as the ground is not frozen. Some disadvantages of B and B are that they are usually more expensive and the soil ball adds extra weight and bulk. The larger plants are expensive to install and require heavy equipment, such as a tree spade or hoist.

Container-grown plants - Container-grown plants are less expensive than B and B and also have an intact root system. These plants are grown in the containers. They can be planted in the spring, summer, and fall. If plants are kept in containers too long, they become root-bound. They are seldom available in sizes larger than a ten-gallon container.

Preparing Soil

Soil assessment - An assessment of the soil in the planting site should be made before planting. The texture, structure, and depth should be checked. The soil should also be checked for compaction. A soil test should be run before the soil is prepared so that fertilizer deficiencies and pH can be corrected. Soil test samples can be sent to a local extension agent. They will provide both results and recommendations.

Additions - After the soil test results and recommendations have been returned, work the recommended materials into the back-fill soil. Do not add more fertilizer to the soil than is recommended. Nutrients should be used in a slow-release form. Do not pour high-analysis fertilizers directly into the planting hole. There is a danger of burning the roots when this is done. Some landscapers choose to place a slow-release planting tablet around the rootball when they plant. They should be placed in the hole after it is one-half full of back-fill. A water-soluble or liquid fertilizer could be used instead. This is applied when the plant is watered-in. Follow package directions. The planting hole is a transition zone for new roots to grow into. This transition zone helps the roots to move from the prepared soil into a usually less favorable clay soil. The size of the hole is determined by the soil conditions.

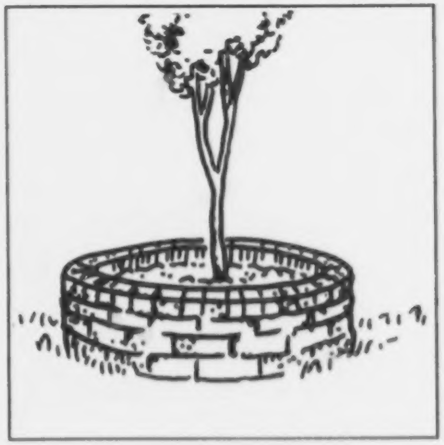
Drainage and aeration - The soil texture and structure determine drainage and aeration. To determine how well-drained the soil is, fill the planting hole with water. If all the water drains out within the first 18 to 24 hours, drainage is satisfactory. If not, then either choose water-tolerant plants or install drainage tiles.

Plow-pan soil - If the soil is compacted or has a heavy plow pan beneath, as in old farmland, the planting hole must be deep enough to go below the compacted zone. The back-fill soil should contain soil from below the compacted layer, plus organic matter.

Shallow soil - A shallow soil can either be used by making a raised bed or drilling through the plow pan below the hole and filling with surface soil mixed with organic matter. See Figure 1.2 and Figure 1.3.

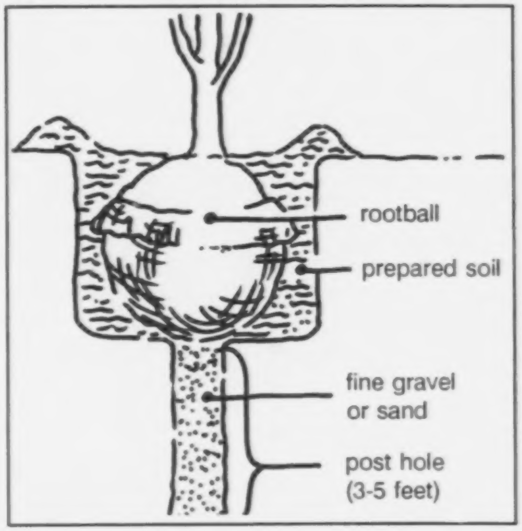
When using organic material with the soil, nitrogen must be added to replenish the nitrogen used by the microorganisms that break down the organic material. A rate of one to two pounds of nitrogen per 1,000 square feet is recommended.

Figure 1.2 - Raised Beds for Poor Soils



Sand is not an ideal amendment for clay soils unless it constitutes 45% of the soil volume. The clay particles will settle into the pore spaces between the sand and produce a less porous soil.

Figure 1.3 - Planting in Tight Clay Subsoil



Transplanting

Timing - At some time, a plant may need to be moved from one area to another. In the nursery, the plants grown in the field need to be dug before they can be moved to the homeowner's site. This can be done at most times of year, but the best time is when the weather is cooler and cloudy or when the plant is dormant or semi-dormant. Roots will be lost in the process so it is essential that the leaves be kept cool and shaded while transplanting. This is not as important if the tree or shrub is dormant.

It is best not to plant in late spring or summer when the plant top is growing rapidly. Winter planting is fine for some species, but desiccation or cold injury may occur with broad-leaved evergreens. The goal when transplanting, is to choose a time when root growth will exceed shoot and leaf growth. Early autumn is the best time. At this time the roots will grow as long as the ground is not frozen, and the cool weather promotes dormancy of the tops. Early spring is the second best time, since the roots have a chance to get established before the shoots and leaves grow. Plants can be moved bare-root, or balled and burlapped. This depends on the time of year and the kind of plant.

Preparation - When transplanting the planting hole should be prepared ahead of time so the process can be done as quickly as possible. The soil should not be too wet or dry when transplanting. The rootball will not hold together if either of these occur, damaging the root system. When transplanting larger trees, it is a good practice to root prune several months to a year before moving the plant. This is done by marking a circle around the trunk. The size of the circle is measured by allowing 12 inches of diameter for every inch of trunk. Use a spade and cut around the circle and as deep as the spade. This promotes new root growth around the circle and lessens the loss of roots during actual transplanting.

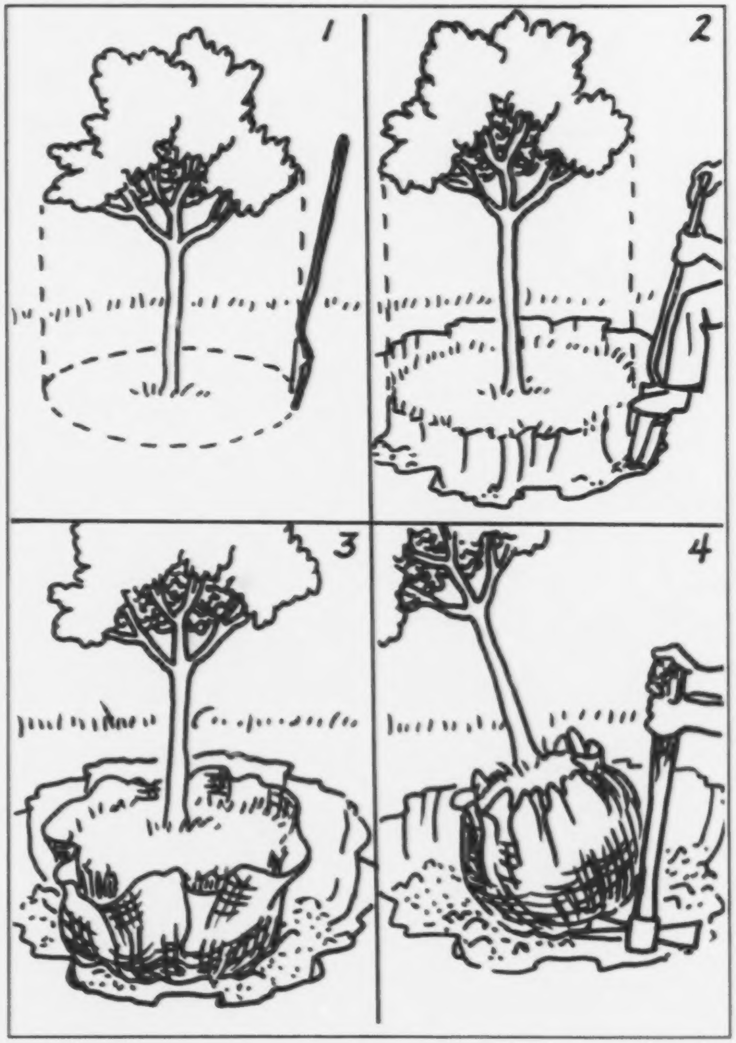
Plant digging - When transplanting, begin digging outside the circle cut when root pruning, so that most of the new roots will be contained inside the rootball. Use a sharp spade. If root pruning is not feasible (and it rarely is feasible in the rush of the landscape season), proceed to dig the tree using 12 inches for every inch of trunk diameter or around the drip-line of the tree. See Figure 1.4. Dig a trench following the circle as deep as the ball is wide and as wide as the spade, or more if more work room is needed. Do not pry against the ball with the spade, because this can damage the ball. After the trench surrounds the rootball, start shaping into a spherical shape by undercutting the ball, while trimming any roots, as needed. The rootball will then be sitting on a pedestal of soil. Cut any roots in the pedestal with a spade. Tip the soil ball on its side, bringing the burlap underneath and around the soil ball. Pull the burlap tightly while fastening with nails used as pins. The burlap should enclose the entire rootball tightly. Then bind the top with a sturdy cord, going around the ball for support.

Plant removal - The best way to handle a tree is by lifting it out by the soil ball. The cords that crisscross the soil ball may also be used. Pulling on the tree trunk can result in breaking of the rootball, which, in turn, can break the roots. Larger trees may need to be moved by a hoist or crane.

Planting Procedures

Planting hole preparation - The first step in planting a bare-root, balled and burlapped, or container-grown plant; is to prepare the planting

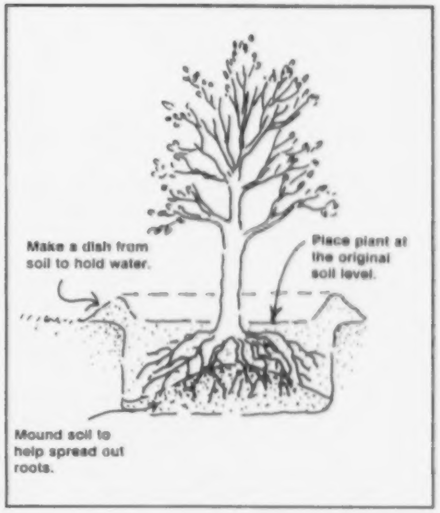
Figure 1.4 - Transplanting - Digging a Plant



hole. For bare-root plants, the hole should be just large enough not to cramp or bend the roots. For B and B and container-grown plants, the planting hole should be six inches wider than the container width on all sides. When digging, the sides of the hole sometimes become glazed. The roots may not be able to penetrate this glaze and grow into the native soil. Therefore, the sides should be roughened with the spade before the plant is set. A mound of soil four to six inches thick should then be placed in the bottom of the hole, when planting bare-root plants.

Plant orientation - The orientation of the plant should be decided. If the site has windy conditions, the side of the tree with the most branches should face into the wind. For bare-root plants, the largest root should be placed into the wind. If wind is not a consideration, place the most pleasing side of the plant toward the most viewed area. Place the side of the tree with the lowest branches away from areas of activity. Place the highest branches on the side with the most activity, i.e., sidewalk underneath.

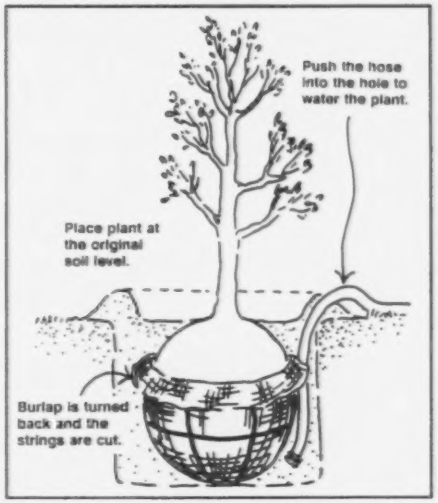
Figure 1.5 - Planting a Bare-Root Plant


Make a dish from soil to hold water.
Place plant at the original soil level.
Mound soil to help spread out roots.

Bare-root planting - Before planting bare-root plants, be sure the roots are healthy. They should be fresh, not wilted or shriveled. To be sure they are ready, soak them in a bucket of water overnight before planting. Any dead, twisted, broken, or diseased roots should be pruned back to healthy tissue.

Place the roots spread out over the cone-shaped mound of soil. See Figure 1.5. Stakes should be set after the plant is in the hole and before the back-fill soil is added. They should be stuck down into the undisturbed soil. Fill the hole about three-fourths full while gently tamping in the soil with the end of the spade around the roots. The original soil with no amendments can be used for back-fill. Since there is not a different soil around the roots, a transition zone is not needed. Water the soil thoroughly. When the plant settles, adjust it by grabbing the trunk of the tree and while rocking it gently back and forth, gently pulling up until the tree is no deeper than the original soil line. This is seen at the base of the trunk. This cannot be done with container-grown or B and B plants, or else the rootball will break. Proceed filling the hole, adjusting the tree as necessary. Water it in again. Make a berm, or dish, around the tree as shown in Figure 1.5. The berm should be around the outside edge of the planting hole and about four to six inches high around the outside. Keep the soil six inches away from the trunk to prevent a wet environment which can cause crown rot. This directs the water to stay in the area above the root zone, soaking down instead of running off. Mulch can be spread on the top. A bare-root plant does not need a lot of water until it begins to leaf out. Be sure not to overwater or roots will rot.

Figure 1.6 - B and B Planting


Push the hose into the hole to water the plant.
Place plant at the original soil level.
Burlap is turned back and the strings are cut.

Balled and burlapped planting - To plant B and B plants, carefully set the soil ball into the bottom of the hole. See Figure 1.6. The top of the rootball should be at the original soil level. Untie and remove the string around the top of the burlap and spread the burlap open. Fill the hole with prepared back-fill soil about one-half full. Firm it with the end of the shovel. If stakes are necessary, they should be placed at this time. Fill the remainder of the soil up to the level of the hole, firming in the process. Cut away any excess burlap showing above the soil line. If left exposed, burlap will act as a wick drawing up moisture and drying out the rootball below. Build a berm (dish) to keep water in. Water the plant thoroughly.

Container-grown planting - Before planting a container-grown plant, it must be removed from the container with little disturbance to the rootball. Plants are fairly easy to remove from plastic pots. Holding one hand over the soil, turn the pot nearly upside down and tap the edge of the pot on a solid surface. This should loosen the roots from the side of the pot and allow the plant to slide out into one's hand. Larger plants can be placed on their side and slid out of the container. Metal containers will have to be cut with can cutters. Two cuts opposite each other will do. Bend the metal back and take out the plant by the rootball, not the stem or trunk. Handle the cut metal with caution, as it is sharp and can cut skin easily.

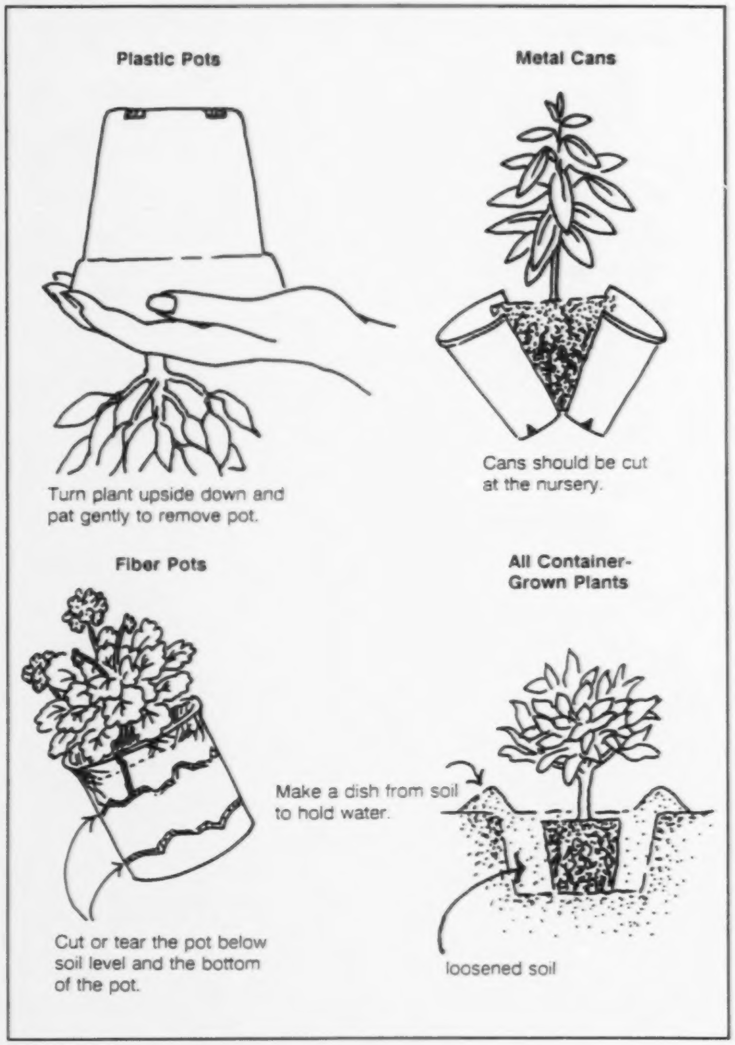
Fiber pots should be torn away below the soil level. The bottom of the pot may also be torn away to give the roots room to grow.

Container-grown plants can be root-bound. If so, loosen or cut circling roots at the bottom of the rootball. Cut several shallow vertical lines on the sides of the rootball with a knife. This will stimulate new root growth. The rest of the planting procedure is similar as planting a B and B plant. Place the container-grown plant in the bottom of the hole so the top is at the same level as the hole. See Figure 1.7. Fill the hole about one-half full with back-fill. Firm the soil in around the roots. Stake if necessary. Finish filling the hole, firming in the process. Make a berm (dish) around the tree, at the outside edge of the hole. Water thoroughly. Mulch can then be added to the top to hold in moisture..

Mulches

Purposes of mulch - Mulches are applied to the soil surface of the planting area. Mulches help retain water in the soil around the rootball while plants are getting established. Mulch also helps keep weeds

Figure 1.7 - Planting Container-Grown Plants


Plastic Pots
Metal Cans
Turn plant upside down and pat gently to remove pot.
Cans should be cut at the nursery.
Fiber Pots
All Container-Grown Plants
Make a dish from soil to hold water.
Cut or tear the pot below soil level and the bottom of the pot.
loosened soil

down. It looks good and it stabilizes the temperature around the planting. This helps prevent winter heaving caused by repeated freezing and thawing.

Characteristics - Mulch should be used in all plantings. It is one thing that remains consistant in the procedures for planting the three forms of plant material. A mulch must be two to four inches thick to be effective. A shallower mulch allows weeds to sprout. Black plastic or landscape fabric will help prevent mulches from mixing with soil and becoming unsightly. Black plastic may cause water logging and not allow oxygen to reach the roots. On slopes, mulch can be washed off the plastic. The plastic should be cut to allow water and oxygen to get to the plants. Landscape fabric, a weed barrier mat, is often used intstead of plastic. It allows oxygen and water to pass through, while still keeping weeds down. Landscape fabric is a better choice around plants.

Types - Some possible organic mulches are wood chips, shredded bark, lawn clippings, and pine needles. Inorganic mulches include crushed stone, marble chips, brick chips, or river rock. An advantage of inorganic mulches is that they do not alter pH or use nitrogen in decomposition, since they do not decompose.

Mulches should not be placed within six inches of the trunk. Otherwise crown rot may occur from excess moisture, rotting the trunk.

Summary

Some key differences between planting each of the three forms of plants are as follows. Bare-root plants should be placed on a mound of soil and can be filled in with the original soil. Root-bound container-grown plants must have the roots loosened or uncoiled. With balled and burlapped plants, the cord wrapped around the ball must be removed; the burlap is left on. Container-grown and balled and burlapped plants are not placed on mounds.

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Several procedures can be done to plants after they are transplanted. These procedures help ensure that the plant gets a healthy start in its new home.

Staking and Guying

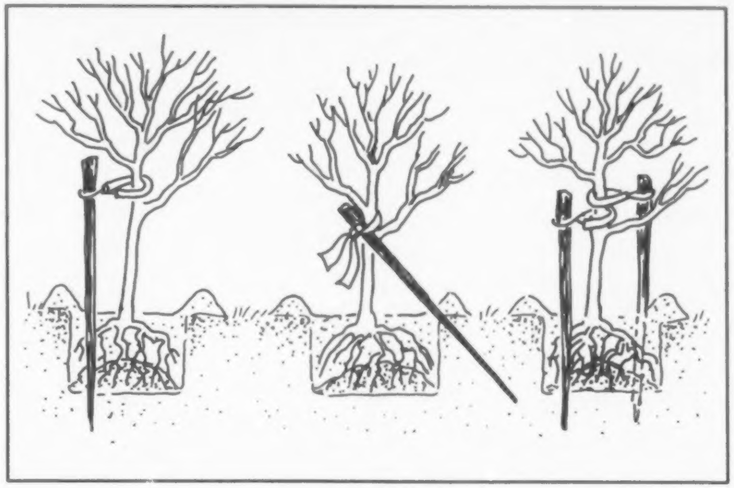
Why support may be needed - A tree trunk develops a strong taper and gains caliper (diameter of the trunk) by being exposed to wind and weather. This and lower, lateral branches help concentrate energy in the trunk. If a tree is staked when young, it can develop a weak trunk. If a tree is grown too close to others in the nursery, shading out lower branches, or if the lower branches are removed; a tree will be weak and need support when transplanted at a later time.

Purposes of staking - Staking is used for root anchorage until the trees are established. Staking is also done for support and for protection from injury.

Support stakes should be used if the tree is too weak to stand on its own and to secure the roots from moving. If the rootball moves after new roots have grown, these roots will be broken off, damaging the plant. Support staking is usually necessary through the first year or until the plant can stand on its own. At the end of the first growing season, check to see if the tree can be unstaked. Even if it is ready, leave the stakes in place until spring to protect the tree from winter ice or snow damage. If not ready, the top may need to be trimmed to reduce weight and wind resistance.

Smaller trees are staked, depending on size, by three methods: slant method, one-stake method, or the two- or three-stake methods. Insert stakes (2 x 2" treated wood or a T-iron) at least 18" deep, extending no more than two thirds the height of the tree. They should be placed parallel to the trunk. See Figure 2.1. Ties should be looped around the trunk and attached to the stake within two inches of the top of the stake.

Figure 2.1 - Tree Staking Methods

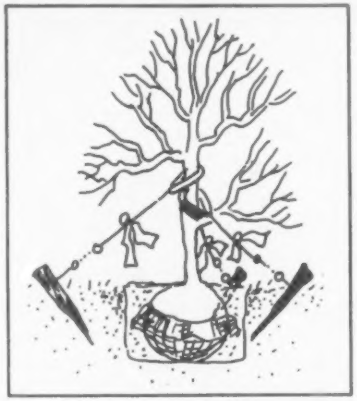


Guying - Larger trees greater than three inches caliper have more foliage, hence more wind resistance, and need greater support. Guy wires are used for this purpose. See Figure 2.2. Compression springs or turnbuckles may be used to keep the wires tight. Three or four wires are attached to a protective collar around the trunk above the first set of branches. The wires should be flagged with reflective tape or cloth for easy visibility. The stakes are inserted in the ground at angles toward the tree. The guy wires should make 45° angles with the trunk and ground.

Precautions - The materials used to wrap around the tree should be flexible enough not to rub away bark, and loose enough not to cut into the bark girdling the trunk. This prevents the flow of water and nutrients through the trunk, killing the tree. Wires should be wrapped with rubber hose or other soft materials available on the market.

If the stakes must be replaced later with new or larger stakes, use the same hole in the ground to prevent damage to the roots.

Figure 2.2 - Guying



Staking can cause a weak tree to grow stronger. It causes it to grow taller without a significant trunk caliber to support it. Therefore, staking should be done only when necessary, and not left on too long or the tree will never be able to stand on its own.

Wrapping

Purposes - Wrapping the trunks of newly-transplanted trees is sometimes done to protect the trunk from sunburn, sun scald, and water loss. It also reduces animal injury due to mice, rabbits, or deer chewing on bark; or damage caused by cutting too close to the tree with a weed trimmer.

Materials - Trees are wrapped with a special paper or burlap. Latex paint is sometimes used; although it is not very attractive, it is easier and cheaper. As the trunk size increases, the paint cracks, exposing the new bark to the sun at a gradual rate.

The tree wrapping paper is used most often. The trees should be wrapped from the ground up in a spiral, overlapping about one-half the width of the material. Wrapping in this direction repels rain and sprinkler irrigation. The wrapping could be fastened by a rope spiralling opposite the direction of the wrapping. It could also be fastened with electrical tape. If it gets wet, problems with fungus may occur.

Wrapping can stay on the tree until it disintegrates or for one year, whichever comes first. It should be checked periodically to be sure no insects or fungus are damaging the tree trunk. If such damage occurs, the wrapping should be removed.

Anti-transpirants

Purposes - When transplanting (moving) a plant, leaves are sometimes stripped or anti-transpirants are used. This cuts down on the amount of moisture the plant loses through the leaves during and after moving, until the plant is reestablished. Sprays may reduce water loss during the growing season; during a drought; and during the winter on conifers and other evergreens to prevent winter burn in cold, dry winters.

Kinds - Anti-transpirants are chemical sprays applied to plants to reduce transpiration. There are three kinds. One is a material that reflects radiant energy away from the leaf, thus lowering the leaf temperature and reducing transpiration. Another is a wax, plastic, or latex film that is sprayed thinly; thus blocking the stomata and reducing water loss, i.e. Wilt Proof™. The third kind is a chemical spray, which prevents the guard cells around the stomata from allowing the stomata to open fully; thus cutting down on the amount of water lost through transpiration. All of these have disadvantages. The reflecting material has a light color, which is not pleasing to the eye, and limits photosynthesis.

The wax, latex, or plastic films cut down on the amount of carbon dioxide absoprtion necessary for photosynthesis. The chemical that prevents stomata opening allows light for photosynthesis and lets in carbon dioxide; but is phytotoxic to many plants and contains mercury, which contaminates the environment. An exfoliate is sometimes used to cause the tree to drop its leaves, thus no transpiration can take place. This is done in extremely hot weather. It is not aesthetically-pleasing, but very effective.

The wax, plastic, or latex transparent films are used most often. They usually last around two to three weeks, depending on the atmospheric conditions and how well they were applied. The new growth that occurs after application will not be covered; thus, the plant will lose water through this area. A second application may be hazardous to the plant, in that it will cut down on photosynthesis.

Cautions - Anti-transpirants have a toxic effect on some plants. The concentration of anti-transpirant must be carefully figured and the species to be sprayed must be considered. Toxic effects show up more on evergreens than deciduous plants. Anti-transpirants should be used sparingly and only when necessary.

Pruning

Container-grown plants do not need to be pruned after transplanting because they have all of their roots intact. B and B and bare-root plants have only ten percent of their roots, so it seems logical to prune back the branches (leaf surface area) to compensate for root reduction. Some studies show that the branches and leaves should be left on to manufacture food for the plant and to promote root growth. Other studies show that there is a chemical formed in the terminal buds that stimulates root growth. To compensate, it is best to prune back only the longest branches one-fourth or no more than one-third. Instead of removing the terminal end of the branch, remove only the lateral branches.

Alternatives - The actual size of the plant does not always have to be reduced. If branches are thinned out that are close together, crossing each other, or broken; this may be enough to reduce the leaf area without reducing the size of the plant. One-fourth of the plant size can be removed without affecting the visual pleasantness of the plant. A plant should not be pruned when planted, if it was recently pruned in the nursery.

Fruit trees are usually pruned to promote low branch growth. Also, plants may be pruned at this time if the branch structure is not desirable.

Summary

Wrapping, staking, guying, and pruning are all essential to the successful establishment of newly-planted trees and shrubs. This type of follow-up care can affect the long-term look of the tree or shrubs.

Credits

Ferguson, Barbara, ed. All About Trees. San Francisco, CA: Ortho Books (Chevron Chemical Co.), 1982.

Harris, Richard W. Arboriculture. 1st ed. Englewood Cliffs, NJ: Prentice Hall, Inc., 1983.

Ingles, Jack E. Ornamental Horticulture: Principles and Practices. 1st ed. Albany: Delmar Publishing Co., 1985

Wilson, Scott. Landscape Maintenance. 1st ed. San Luis Obispo, California: California Polytechnic State University, 1982.

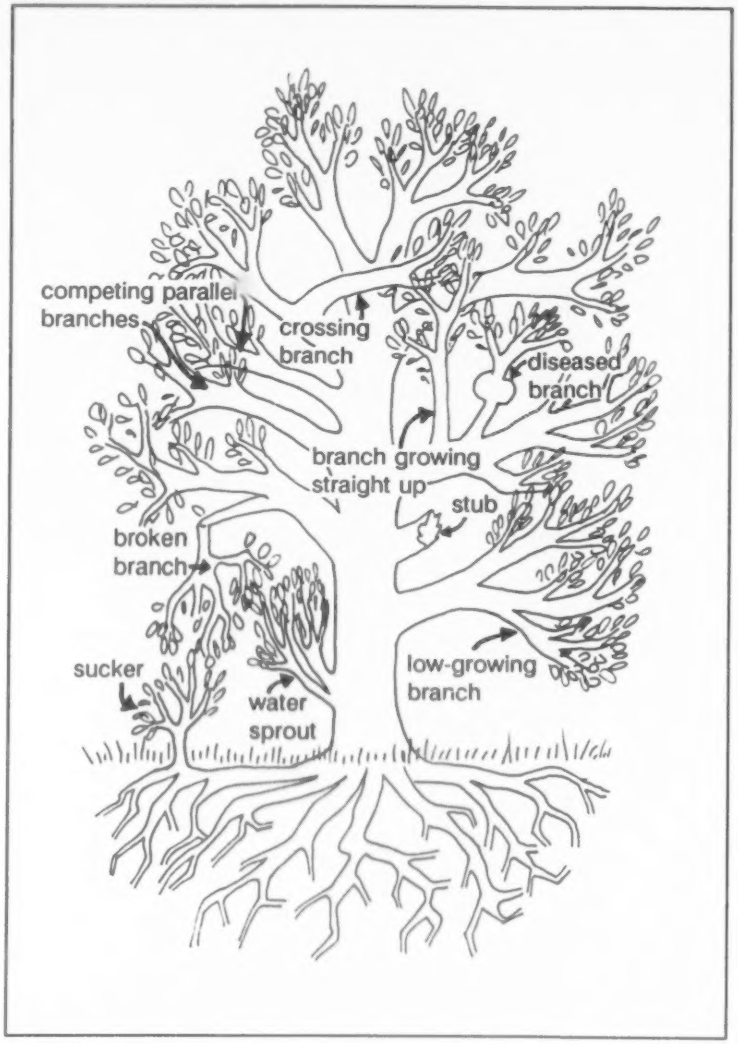
Pruning is the removal of any part of the plant. Regular maintenance of trees and shrubs includes pruning. Pruning is an art. It takes experience to know what type of pruning is required to get the desired effect.

Purposes

As discussed previously (Unit VI, Lesson 2); trees are pruned at time of planting to increase their chance of survival. Pruning reduces the top growth to compensate for root loss. The size and shape of a tree or shrub can be altered by pruning. Pruning is done to correct any undesirable growth such as crossing branches; weak, narrow, crotches; multiple leaders; and water sprouts. See Figure 3.1. Low-hanging branches and branches that interfere with traffic should be removed by pruning. Fruit trees may be pruned to reduce a heavy fruit load that could break the branches. Pruning also reduces the production of lots of small fruit instead fewer, larger fruits are produced. Pruning will reduce the size of the plant and invigorate new growth.

Removal of damaged branches - A major reason for pruning is to remove old, weak wood; broken, dead, or dying branches. A large amount of dying branches may be serious to the health of the tree. There are several reasons that branches die back; excess shading, insects, diseases, mechanical injury, lightening injury, and air pollution. Damage to the root system can also cause branches to die back. These damages occur from improper fertilization, drought, excess water, poor soil aeration, soil pollution, insects, and diseases. Whenever removing diseased branches from a tree, be sure to disinfect the tools used before pruning the next tree. Many diseases can be transmitted from tree to tree by the pruning tools. Also be sure the tools are properly disinfected and cleaned before storing. A solution of chlorine bleach or alcohol can be used.

Figure 3.1 - Undesirable Growth



Plant Responses to Pruning

Pruning causes three different responses in plants. These are dwarfing, invigoration, and a change in growth habit.

Dwarfing - A plant that is pruned is invariably smaller than a plant that is not pruned. This is not always easily seen because the vegetative growth stimulated by pruning, masks the reduction in size. Although vigorous growth occurs with pruning, the plant is still dwarfed if compared to a plant that is not pruned.

Invigoration - Pruning invigorates and rejuvenates plants. Carbohydrates are located in the upper portion of the plant (branches and leaves). The roots are absorbing nitrogen from the soil to supply nutrients which form the carbohydrates that support the plant. When branches and leaves are removed from the plant, some of the stored carbohydrates and the carbohydrate-producing parts are removed, while the roots are still supplying the same amount of nitrogen. Thus, there is an increased amount of nitrogen present when compared to the carbohydrates. This causes the plant to shoot out new vegetative growth.

Root pruning causes the opposite effect; thus, more flowering and fruiting occur from an increased carbohydrate level. Heavy pruning increases vegetative growth and lighter pruning favors reproductive growth.

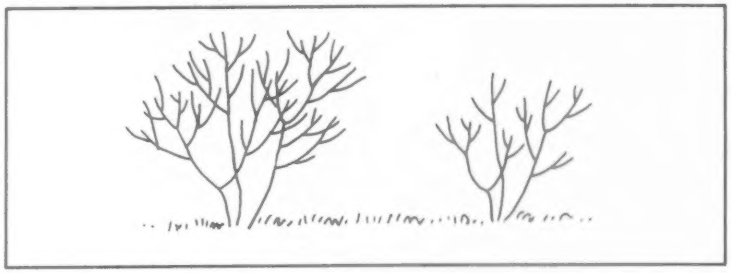
Change in growth habit - Pruning affects the growth habit of a plant. Strong apical dominance gives conifers their strong pyramidal shape. The apex (top bud) grows faster than the lateral buds. Therefore, the lateral branches remain shorter. Removal of this apical bud (terminal bud) stimulates growth of the lateral branches, thus producing a bushier plant. A caution for deciduous and coniferous trees: stimulation of the lateral branches causes them to grow in a more upright direction creating weak, narrow crotches that are more susceptible to breakage. This response is more desirable in shrubs and hedges. Branches that grow in a horizontal direction produce more flowers and fruit. Apical dominance is stronger in young plants and reduces with age. This is why some conifers have a strong, pyramidal or conical shape when young; and a more rounded, spreading shape when mature.

Types of Cuts

There are primarily two types of pruning cuts. These are "heading back" and "thinning out."

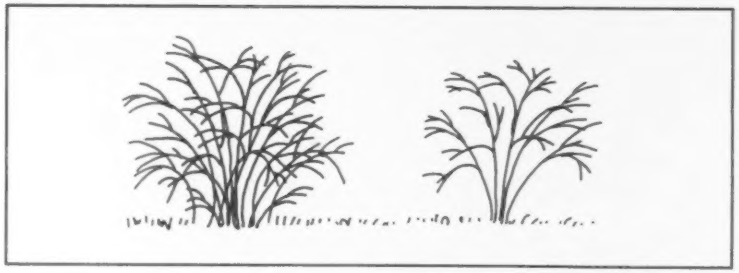
"Heading back" - "Heading back" is a procedure that involves cutting off part of a limb or branch. See Figure 3.2. If the branch is pruned lightly, the buds nearest the cut will be stimulated to grow. If this bud faces away from the plant, the direction of the new growth will be away. Thus, the direction of plant growth can be determined by the placement of the cut. A slightly heavier cut will stimulate latent buds farther down on the remaining branch. This creates a bushier, fuller looking plant. Shearing is a type of "heading back". This type of cut is done on hedges that are to be kept in a very exact shape and look very formal. Shearing removes only the tips of the stems, causing a dense amount of foliage to grow at the outer extreme of the plant. Inside the branches is often bare since little light can penetrate the outer leaves.

Figure 3.2 - "Heading Back"



"Thinning out" - "Thinning out" is the other type of cut. This procedure involves the removal of an entire shoot or branch. See Figure 3.3. This is the method used to remove old, weak wood; crossing branches; and unwanted growth. Branches can be removed back to another branch, or the entire branch or shoot can be removed at the ground (pruning rose canes). This pruning method leaves the plant more open and simplified. It allows light to penetrate the crown so the leaves beneath will grow better. Sometimes branches near the removed branch grow or sprout suckers around the cut. These should be cut off.

Figure 3.3 - "Thinning Out"



Pruning Procedures

"Pruning cut" - When heading back, there are several ways to make a wrong cut and one right way. The cut should be one-fourth inch above the bud at a 45° angle. See Figure 3.4. Besides not leaving a stub, one should also not cut under the bud. This can cause the bud to die. Using the proper tools is essential in making a clean cut. Pruning shears are best for this type of cut.

Figure 3.4 - Pruning Cuts

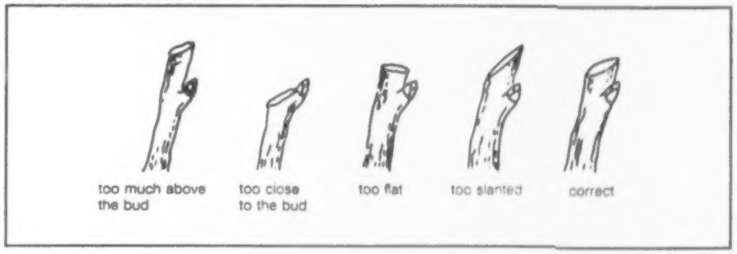
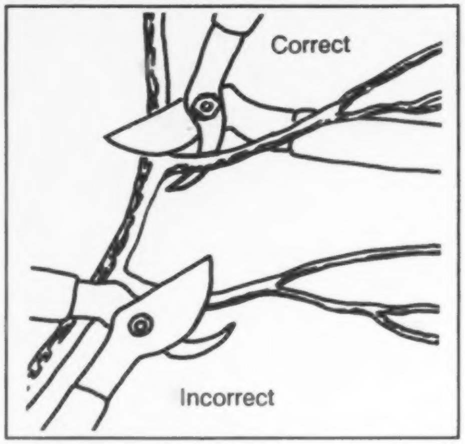
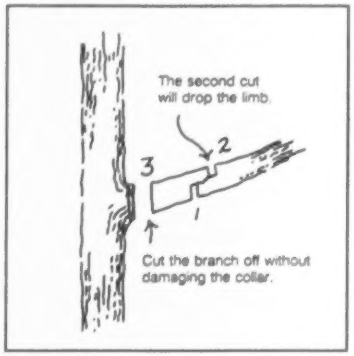

too much above the bud
too close to the bud
too flat
too slanted
correct

Figure 3.5 - Pruning Smaller Branches



Smaller branches There are two different procedures for removing a branch or limb. One procedure is for smaller, lighter branches and the other for larger, heavier branches. Smaller branches are usually cut with pruning shears or lopping shears. Figure 3.5 shows the correct and incorrect procedures. The cut should be made with the blade of the shears closest to the main trunk and the hook below, away from the plant. The cut should be made flush with the main trunk. If the shears are not placed correctly, a stub will be left. A pruning saw may be used if the limb is too large for pruning shears or if the space is too small to get the shears in the proper position. In this case, make two cuts with the saw. Cut first on the underside of the branch and second on the upper side of the branch. Try to make the cuts meet in the middle.

Figure 3.6 - Three-Part Cut


The second cut will drop the limb.
2
3
1
Cut the branch off without damaging the collar.

Larger limbs - Remove larger limbs with a pruning saw, making a three-part cut. This is done to prevent tearing the bark away from the tree. See Figure 3.6. Make the first cut halfway through the under side of the limb about three to four inches out on the limb; make the second cut halfway through the upper side of the limb about one to two inches out from the first cut. The weight of the branch will cause the branch to break away. Remove the stub with the third cut. The third cut should be made outside the wrinkled growth (callus layer) on the upper side of the limb. Follow Figure 3.6. If cut too close to the tree, cells that prevent disease from entering into the main trunk via the wound are removed. This endangers the tree.

When shearing hedges, be sure the hedging shears are sharp, so they do not tear the foliage. A clean sharp cut makes the plant look better.

Pruning wounds larger than one and one-half inch can be sealed with an antiseptic wound dressing. This prevents disease from rotting the wood, creating a cavity. Tree paint can be sprayed on. This treatment can be given as soon as the wound is made.

Pruning Procedures for Various Plants

Evergreen plants - Conifers do not usually need pruning. Coniferous evergreens are divided into two groups, whorl-branching species (fir, pine, spruce) and random-branching species (juniper, yew, arborvitae). If conifers need pruning, whorl-branching species are pruned back to a lateral branch or bud. Pines have terminal buds only at the tips of the branches. They can be pruned by pinching back these candles. See Figure 3.7. This promotes the development of closer whorls of branches, making the plant denser. In spruces, to avoid open spaces,prune half of the terminal shoots. See Figure 3.8.

Figure 3.7 - Pruning Pines

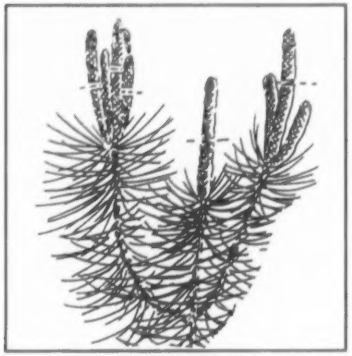


Figure 3.8 - Pruning Spruces

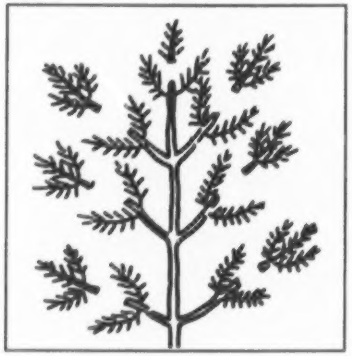


Figure 3.9 - Training a Lateral Shoot to be Central Leader

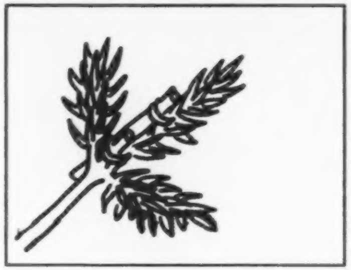
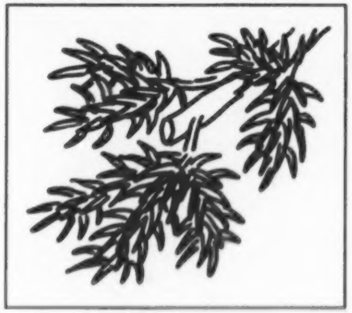


Figure 3.10 - Cut to Cover Exposed Stubs



Avoid damaging the central leader. If this happens, train a lateral shoot to take its place. See Figure 3.9. Never cut back to bare wood, since the tree will not grow from bare wood.

When pruning random-branching evergreens, shearing can be done. These plants can be pruned in just about any way. More compact plants result when long branches are cut back to their junction with a lateral branch during early spring. The cuts should be made "back-in" so that new growth will soon cover exposed stubs. See Figure 3.10. Junipers must have foliage on the remaining stem to grow back. Yews can be cut back to just about a bare stub. Severe pruning should be done in April, but light pruning can be done all year round. In arborvitae and junipers, do not make cuts into the "dead zone" inside the plant where the stems are bare, or they will not grow out.

Very young deciduous trees - Very young deciduous trees need to have their growth directed by pruning. The use of the tree in the landscape and its growth habit are to be determined early. The height of the first branch from the ground determines the use of the tree in the landscape. It could be low so children can play on it, or high if it is a specimen tree or away from traffic arch. This height never changes throughout the life of the plant. A young tree should be pruned only enough to direct its growth and correct structural weakness. The permanent scaffold branches should also be chosen.

Figure 3.11 - Temporary Branches

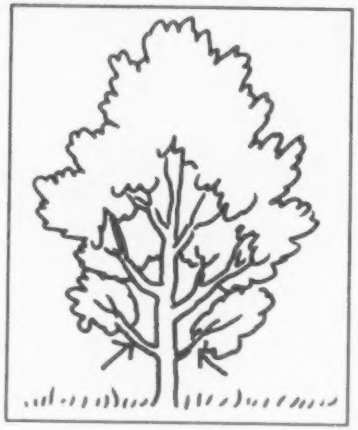
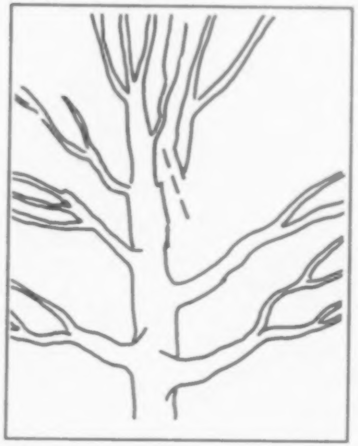


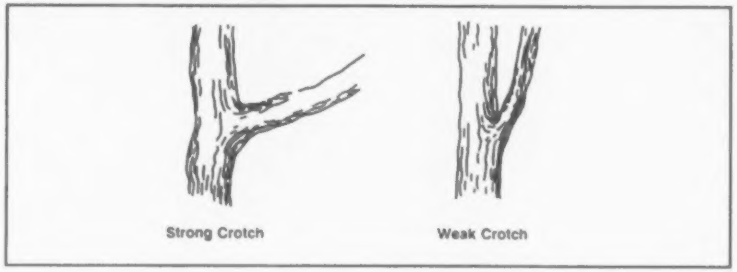
Figure 3.12 - Pruning Lateral Branches



A very young tree should have temporary, lower branches left on the trunk to nourish it. They help the tree develop caliper and protect from sun scald. See Figure 3.11. After the caliper of the trunk reaches two to three inches; they can be removed over a period of two to three years, removing the largest one first. Branches do not move upward. The tree grows from the top rather than the bottom. The branches selected for the lowest limbs, will always remain at that height. Water sprouts grow along horizontal branches and suckers sprout up at the base of the tree. These branches use more energy from the plant than they contribute and should be removed as soon as they begin to grow. Occasionally, lateral branches outgrow the central leader or grow in competition with it. See Figure 3.12. These branches should be pruned back.

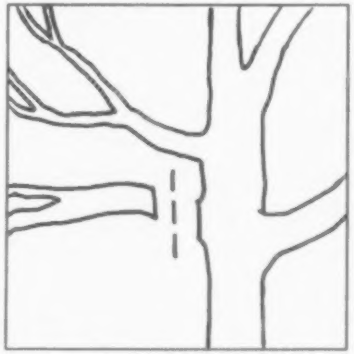
Young to medium-age deciduous trees - As the tree gets a few years older, pruning cuts may be made to keep the tree structurally strong and appealing. The angle of branch attachment should be 45 to 90°. Narrower angles cause weak branches and should be removed. See Figure 3.13.

Figure 3.13 - Branch Angles



Scaffold branches should be 18-24" apart and be spaced around the trunk as much as possible for good support and light penetration. If one branch is directly above another, one of them should be removed. One inhibits the growth of the other. Choose the strongest ones to remain and remove the rest. See Figure 3.14.

Figure 3.14 - Prune One of Competing Parallel Branches

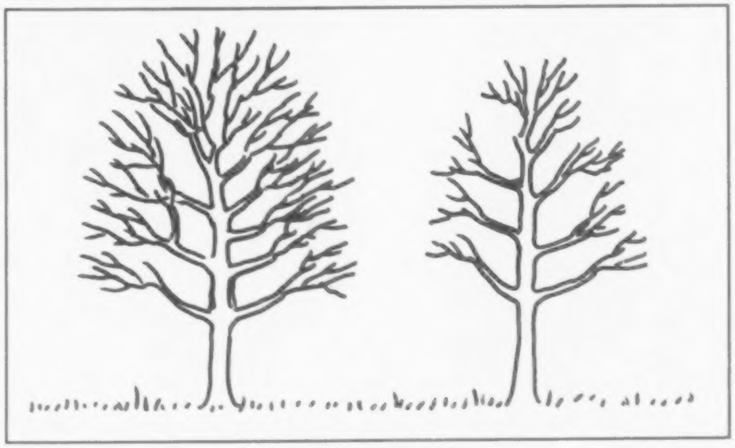


A branch should not be larger than the main trunk or the lateral it is attached to. The larger branch should be "headed back" so it will grow more slowly and the main trunk can catch up.

Mature trees - If trees are maintained as they are growing, they should not need severe pruning when they are mature. Maintenance pruning would be all that is necessary; which would be to remove dead, broken, crossing, and low-growing branches. Minor pruning can be done to keep the crown of the plant in the desired shape. Diseased branches should also be removed promptly. A mature tree can be thinned to open up the canopy without seriously changing the form of the tree. See Figure 3.15.

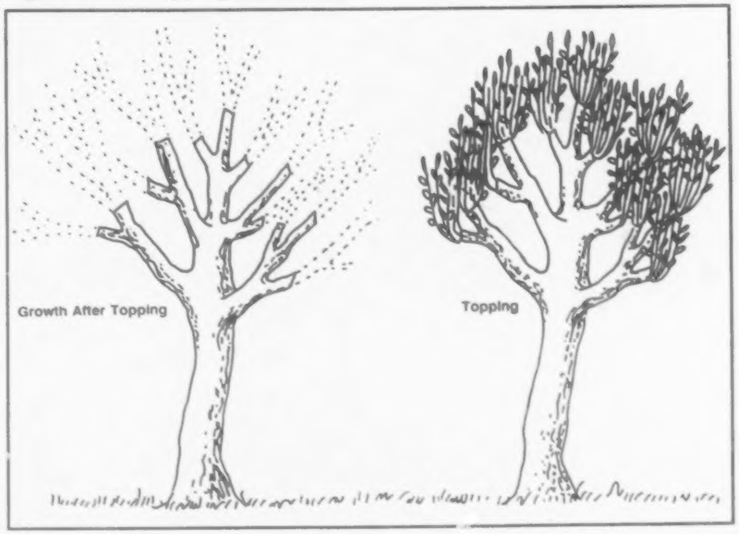
Topping, heading, or stubbing should not be done unless it is absolutely necessary. This promotes vigorous, weak, growth at the outer edge of the canopy. See Figure 3.16. Thinning gives a much more desirable look.

Figure 3.15 - Thinning Mature Trees



Topping, or dehorning, of large trees has been done to trees for several years. Topping is used to remove dangerous limbs from a tree that may damage houses or other structures. There are other reasons for topping, but none good enough to completely mutilate a healthy tree. Topping a tree causes many large wounds, where the cuts are made, that will never heal properly. These areas invite pests and diseases to infest the plant. Also, the abundant growth that occurs after the tree is topped, is weak and more susceptible to wind damage. Topping causes early decline of the tree. The tree is never as strong as it was before topping. People often top trees because the tree has grown too large for the space they have or too close to the house. A better alternative to topping is to trim away a few of the most dangerous or annoying branches.

Figure 3.16 - Topping Trees



Trees that have potential of seriously damaging a home should be cut down and replaced by a new tree. The proper tree must be selected to fit in the area where a tree is desired. Do not plant tall trees below electrical wires or within 20 feet of the house. Plant a smaller variety and give the tree plenty of room to grow.

Pruning large trees is dangerous without the proper equipment. It may be better to hire an arborist to prune the tree, but be sure the arborist is well-trained and qualified. Desire and purpose of pruning should be made clear to the aborist before work is begun. Avoid topping a tree.

Before the start of the pruning job, stand back and look at the tree. Get an idea of how the tree should look when pruning is completed. Start with dead, broken, diseased, or crossing branches. Then prune to shape the plant.

Ornamental deciduous trees - Ornamental deciduous trees can be pruned throughout most of the year. There may be some specific exceptions. There are advantages and disadvantages for pruning at each season. Early spring is probably the best time. The branches are still bare and the buds are swelling so one can see what is being pruned. Avoid breaking off the buds. Landscapers tend to pick their slow times to prune, which are mid-summer and winter. The leaves on the trees hide branches in the summer, so some may be missed. If it is pruned too late in the summer, the plant may be susceptible to winter injury. If winter pruning is done, prune after the coldest period of winter. Fall is usually a poor time to prune, since pruning wounds are more susceptible to fungus diseases, and the cuts take a longer time to heal.

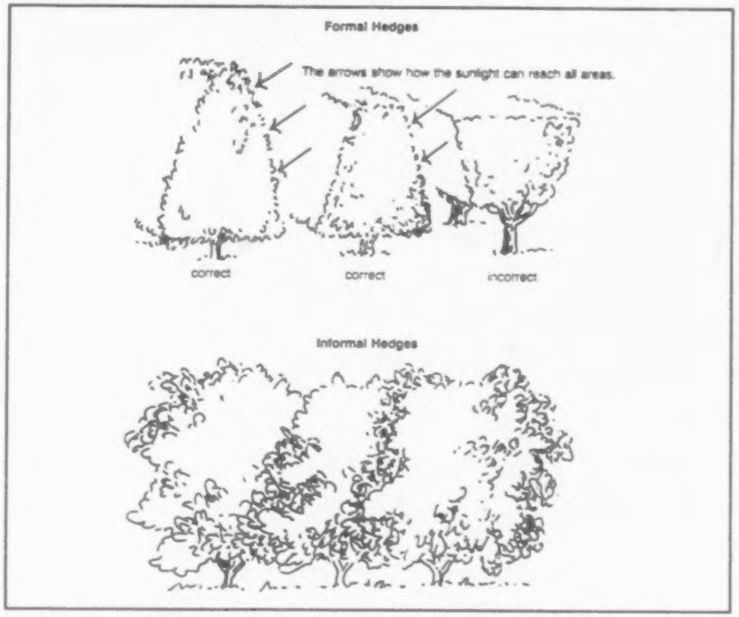
Shrubs - Shrubs are divided into two groups: early-spring flowering; and summer and fall flowering shrubs.

Spring flowering shrubs include forsythia, lilac, and spirea. These shrubs bloom from buds that were produced the previous year. If these plants are pruned in the early spring, all their flowers will be lost. These shrubs should be pruned soon after they bloom. This will allow time for the new growth and next year's flower buds to form before fall. These plants should be pruned first by removing weak growth, dead, broken, diseased, or crossing branches using pruning shears. Start at the top and work down to maintain the shape of the plant. Next, remove as many of the older canes as needed. One-third to one-fourth of the stems should be removed each year so that the shrub is completely renewed every three to four years. Use lopping shears or a pruning saw for these cuts. Remove only those canes that will not change the shape of the plant too much.

Some plants, such as pyracantha and Japanese quince, bloom only on wood older than one year. Therefore, these plants should never be pruned excessively at one time.

Summer and fall, flowering shrubs produce their flower buds on the current season's growth. These plants can be pruned any time before the plants grow in the spring. The same pruning methods described above apply to these shrubs. There are a few shrubs that can be cut back to the ground in the spring.

Figure 3.17 - Pruning Hedges

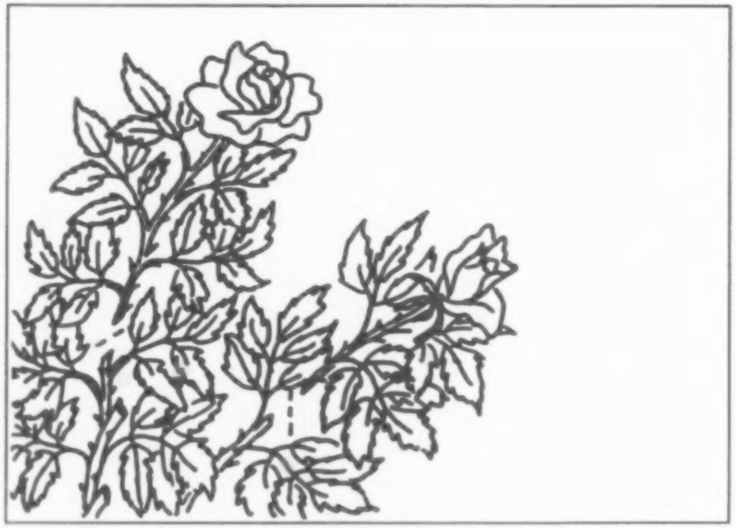


Hedges - Hedges need to be pruned often to keep them in shape. They can be pruned at any time during the year. Hedges should be trimmed wider at the base than the top. If the top is wider than the base, the base will be shaded, causing it to be thin and open. Figure 3.17 shows the right and wrong ways to trim hedges. Hedges can be sheared but they look better and more natural if they are "headed back" in the foliage to make informal hedges.

Roses - Roses require special pruning. Each time a rose bloom is cut off, plants are partially pruned. It is usually best not to cut flowers from a new planting until fall of the first year.

Even after plants are well-established, never cut stems longer than needed. Leave at least two leaves on the stem. See Figure 3.18.

Figure 3.18 - Cutting Blooms



Climate often determines the best pruning time. Roses normally need a light, fall pruning and a more thorough, spring pruning. Where winter temperatures may be damaging, it is best not to prune hybrid teas, floribunda, or grandiflora roses severely in the fall. Remove only the tops of branches that catch in the wind.

In the spring, do not cut back hybrid teas, floribundas, and related types to less than 18 inches unless winter cold has killed them lower. See Figure 3.19.

Climbing roses require various pruning habits. Very vigorous types known as ramblers should be pruned in late spring, immediately after flowering. All old canes that have flowered should be removed close to the base of the plant. See Figure 3.20. This will force out young, vigorous canes for bloom next year.

Figure 3.19 - Pruning

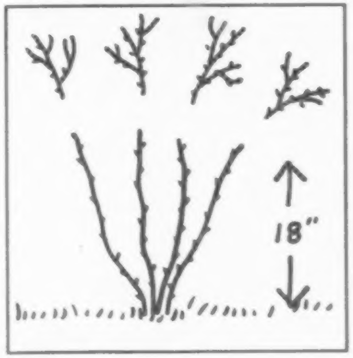
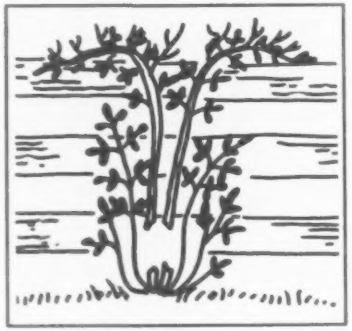


Figure 3.20 - Removing Canes on Climbers



Climbing hybrid teas and some other large-flowered, everblooming, climbers do not need such severe pruning. Many should have little or no pruning for the first two to three years. Prune these climbers late in the dormant period just as buds are breaking, the same for hybrid tea types. Leave only two to three major canes. As new vigorous canes grow from the base, allow them to remain and develop. After they develop, remove any old canes close to ground level to keep the basic two or three vigorous, basal canes.

The best blooms of hybrid climbing teas are produced on short branches coming from two - to three-year-old wood. Allow these short branches to remain and cut them back to two or three vigorous buds per shoot. In summer, remove blooms as soon as they have faded.

The following procedures apply to all types of roses.

1) Remove all dead wood.
2) Remove diseased, broken, or injured wood.
3) Remove shoots from the base that are not from the main plant.

4) Remove crossing branches through the center of the plant or ones that rub on each other.
5) Prune to enhance the shape of the plant.
6) Remove branches to allow good air movement through plant.
7) Make cuts one-fourth inch above a strong bud facing the outside.
8) Cover large cuts with pruning wound dressing.
9) Make cuts clean and smooth by using sharp pruning shears.

Summary

Following a regular, pruning-maintenance program after a tree, shrub, or rose is transplanted will help determine the longevity and beauty of the plant. Proper pruning requires a yearly program, but broken or diseased branches should be removed as soon as they are noticed. Early pruning, within the first three to five years of growth, should be done to establish the structure and form of the tree. Once this is established, the lowest branches should be selected. As the older branches droop down, they should be trimmed out of the way of traffic. The canopy of the tree should be pruned to maintain the proper shape. All pruning cuts should be made with the proper method using the proper equipment. Roses require special pruning. Climate and type of rose help to determine various pruning habits.

Credits

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University Extension Agricultural Publication, UMC:

G06866: Pruning and Care of Shade Trees
G06870: Pruning Ornamental Shrubs

Most of the nutrients needed by plants are available in the soil. Many people like to let nature take its course, but often the result is slow growth and poor yields. It is often necessary to supplement the soil with fertilizers to make up for any deficiencies that may be present.

Macronutrients and Micronutrients

Macronutrients - Carbon (C), hydrogen (H), and oxygen (O) are available to plants through the atmosphere. The soil provides the remaining elements. Phosphorous (P), potassium (K), and nitrogen (N) are the elements most often deficient and must be added to the soil. Plants also need sulphur (S), calcium (Ca), and magnesium (Mg) in large quantities. Elements that plants need in large amounts for good growth are called macronutrients.

Micronutrients - Plants need smaller amounts of micronutrients. They are iron (Fe), boron (B), manganese (Mn), copper (Cu), zinc (Zn), molybdenum (Mo), and chloride (Cl).

The sixteen nutrients needed for plant growth are remembered best by this mnemonic device: "C. Hopkins Cafe Managed by mine couzins Mo and Cleo." It stands for C HOPKNS Cafe Mg B Mn CuZn Mo Cl.

Effects of Nutrients on Plant Growth

Phosphorous - Phosphorous stimulates root formation and growth and gives a rapid and vigorous start to plants. It is essential for energy transfer, hastens maturity, and stimulates blooming. Phosphorous also promotes disease resistance.

Potassium - Potassium promotes vigor and disease resistance of plants and is essential in the formation and transfer of starches, sugars, and oils.

Nitrogen - Nitrogen induces rapid vegetative growth. It is necessary for chlorophyll manufacturing, and produces a healthy, green color. It is also important in the synthesis and structure of protein molecules.

Sulphur - Sulphur encourages more vigorous growth in plants. It also promotes root growth and is essential to the formation of some proteins.

Calcium - Calcium improves general plant vigor. It is a component of the cell wall, promotes early root formation and growth, and influences the absorption of other plant nutrients.

Magnesium - Magnesium aids in the transport of phosphorous and influences the absorption of other plant nutrients. It also aids in starch translocation.

Iron - Iron acts as an electron carrier in enzyme systems that causes oxidation to occur and is essential to chlorophyll production.

Boron - Boron influences water absorption and aids in sugar translocation.

Manganese - Manganese is essential in plant metabolism and for certain nitrogen transformations in plants.

Copper - Copper acts as an electron carrier in enzyme systems, is involved in plant respiration, and aids in utilizing iron.

Zinc - Zinc is important for plant metabolism, is involved in the formation of some growth hormones, and also in the reproduction process of certain plants.

Molybdenum - Molybdenum is essential for plant development and reproduction. It acts as an electron carrier in enzyme systems which causes oxidation reduction to occur in plants. However, it does not have a role unless other micronutrients are present.

Chlorine - Chlorine affects root growth, but little more is known about its effect on plants.

Deficiency Symptoms

If plants do not receive sufficient amounts of essential nutrients, they will begin to show the following signs of deficiency.

Phosphorous deficiency - The symptoms of phosphorous deficiency are slow growth and maturity. The leaves, stems, and branches turn a purplish color.

Potassium deficiency - The symptoms of potassium deficiency are mottling, spotting, streaking, or curling of the leaves. The leaves become scorched or burned starting at the tips and proceeding downward.

Nitrogen deficiency - Nitrogen deficiency symptoms are; a sickly, yellow-green color and a distinct, slow, and dwarfed growth. The leaves burn starting at the bottom of the plant and proceeding upward. The drying starts at the bottom of the leaves and proceeds down the center along the mid-rib.

Sulphur deficiency - In sulphur deficiency, the young leaves are light-green and have even lighter veins. The stalks are short and slender, and the overall plant growth is slow and stunted.

Calcium deficiency - In calcium deficiency, the young leaves in terminal buds become hooked in appearance and then die at the tip and along the margin. The roots are short and branched and the leaves have a wrinkled appearance. Plants could exhibit deficiency symptoms of other nutrients, since the proper balance of calcium influences absorption of other nutrients.

Magnesium deficiency - In magnesium deficiency, the plant loses green color, starting at the bottom leaves and later moving up the stalk, while the veins of the leaf remain green. The plant stem is slender and weak, the leaves are mottled, and the leaf tips are turned or cupped upward.

Iron deficiency - Iron deficiency symptoms include; mottled, young, leaves with the main veins remaining green; and short, slender stalks.

Boron deficiency - Deficiency symptoms of boron show the young leaves of terminal buds becoming light-green at the base. In later growth the leaves become twisted, and the stalk finally dries back to the terminal bud.

Manganese deficiency - In manganese deficiency, spots of dead tissue are scattered over the leaf. The smallest veins tend to remain green, producing a checkered effect.

Copper deficiency - In copper deficiency, the young leaves are permanently wilted without spotting or mottling. The twig or stalk just below the tip and seedhead is often unable to stand erect in later stages of a critical shortage.

Zinc deficiency - In zinc deficiency, leaves begin spotting in areas between the veins. Eventually secondary and even primary veins become spotted. The leaves are thick and the internodes are short.

Molybdenum deficiency - In molybdenum deficiency, the leaves are similar in color to those deficient in nitrogen (a sickly, yellow-green). The leaves scorch on the margins and roll, reducing the width. In severe deficiency, the internodes are short and the flowers are few and small.

Chlorine deficiency - Chlorine is not usually deficient; therefore, there are no known signs or symptoms of deficiency. Table 4.1 summarizes the role of each nutrient and its deficiency symptoms.

Fertilizer Label

Analysis - The information found on a fertilizer container includes the analysis of the fertilizer, which is expressed as percentage by weight. By law, these percentages must be on every bag sold. For example: in a 100-pound bag of 20-10-20, 20% or 20 pounds is nitrogen; 10% is phosphorous; and 20% is potassium. The three numbers found on

570

571

a container of fertilizer are the percentages of N, P, and K in the fertilizer. They are always found in this order.

Ratio - The ratio of a fertilizer is the analysis broken down to the lowest common denominator. For example; the analysis 20-10-20 has the ratio 2:1:2 and the analysis 10-5-10 has the ratio 2:1:2. The two fertilizers supply the same proportions of N,P, and K; but the 20-10-20 supplies twice as much as the 10-5-10. Therefore, two times the amount of 10-5-10 must be applied to get the same amount of nutrients as 20-10-20 supplies.

A low-analysis fertilizer has 30% or less of the total weight available in nutrients. A high-analysis fertilizer has 30% or more of the total weight in nutrient form. The remainder of the weight is filler. The filler is a carrier for the nutrients and may include some micronutrients. A filler may be cottonseed hulls, ground corn cobs, or other organic materials. This makes it easier to apply the nutrients. A low-analysis fertilizer is cheaper per bag than a high-analysis fertilizer, but it is actually more expensive since it takes more of a low-analysis fertilizer to get the same results as a smaller amount of a high-analysis fertilizer.

The ratios of N,P, and K vary for each fertilizer. The three numbers tell the proportion of one nutrient relative to the others. For example, in the 20-10-20 there is twice as much nitrogen as phosphorous and twice as much potassium as phosphorous. Each nutrient has a specific effect on plant growth. When a plant needs to grow more leaves (vegetative growth); a fertilizer with a higher proportion of nitrogen would be desirable. A fertilizer higher in phosphorous or potassium promotes flower and fruit production.

Formula - The fertilizer formula lists the form and amount of each nutrient used in making up the particular fertilizer. For example; it tells whether nitrogen was supplied in the chemical form of ammonium nitrate or fish meal, which is an organic form of nitrogen. The formula also includes any micronutrients in the mix.

Manufacturers formulate fertilizers in various ways to fill the many different needs.

Types - There are three types of fertilizers; dry inorganic, liquid inorganic, and organic. Organic fertilizers are made from natural, living, or once-living organisms like manure, sewage sludge, bone meal, cottonseed meal, and fish meal. Inorganic or chemical fertilizers are manufactured from minerals. Ammonium nitrate, sulphur phosphate, and neurite of potash are all chemical fertilizers. They are cheaper to use, easier to transport, and easier to apply than organic fertilizers.

It is important not to overfertilize as this can cause poor growth just as underfertilization does. There is no difference in plant growth between the use of organic or inorganic fertilizers. Plants cannot tell the difference.

Forms of Nitrogen

Although an element may be present in the soil, it may not always be in a form that can be absorbed by plants. However, ammonium nitrate, sodium nitrate, and urea formaldehyde are three types of nitrogen that are highly soluble and readily absorbed by plant roots.

Sodium nitrate ($NaNO_3$) is highly soluble and tends to lower the pH of the soil. Ammonium nitrate NH_4NO_3 is not quite as soluble, but lasts longer in the soil. It tends to lower pH. Urea formaldehyde is an organic nitrogen and is less soluble and released more slowly.

Organic fertilizers must be broken down by microorganisms into ammonium or nitrate nitrogen before they can be used by plants.

Soil Type and Absorption of Nutrients

The type and pH of soil affect the absorption of plant nutrients. As discussed earlier, the more silt and clay a soil contains, the better it holds nutrients. Although a highly-dense, clay soil can retain excess water; a balanced soil is best.

Also, as discussed earlier, the pH affects nutrient absorption. Although a nutrient may be present in the soil, if the pH is too low or high, it may be tied up and not available for root absorption.

When it is necessary to lower the pH in alkaline soil, materials such as aluminum sulphate, sulphur, or iron sulphate may be used. When the soil is too acidic and needs to have a higher pH, items such as lime or calcium can be used. Lime, which serves as important nutrient in the soil, can help make phosphorous available to plants; but it may make other elements, such as iron, toxic to plants. This is why iron is applied to plants as a foliar spray. This will be discussed later in the lesson.

Determining Fertilizer Needs

It is important to use the proper balance of fertilizers. Landscapers need to know how much of the elements are already present in the soil and how much is needed for the crop being grown. Then they can determine the type, the amount, and the analysis of the fertilizer that should be used.

Usually by the time visible symptoms of nutrient deficiency are showing, the plant may already be damaged. It is best to determine the plant's nutrient requirements before reaching this phase. This can be done in several ways. Knowing from past experience is one way. The state extension office usually prints fertilizer requirements for major plants. The nursery where plants are purchased may have this information. A soil test is the best way to determine what the soil contains and what it needs. There are soil testing kits available to buy, or one can send soil samples to the state soil testing laboratory. A soil test can determine the existing nutrients, the pH, and a recommendation of nutrients needed. A foliar analysis can also be used to determine nutrient needs. A sample of leaves is sent to the laboratory for testing. The test, determines the nutrient content and recommends a fertilizer to fulfill the nutrient requirements.

One must determine if the poor health of the tree is actually a result of poor nutrition, or other reasons, before applying fertilizer. Plants usually show signs of malnutrition with poor tree growth, pale green or yellow leaves, mottled patterns between the veins, dead spots, stunted leaves, or early loss of leaves. An improper planting location, improper watering, or poor drainage can also cause these signs to occur.

Rate of tree growth can be determined by measuring downward from the tip of the twig to the first ring of bud scale scars; this is the current season's growth. The distance between these bud scale scars and the next set down determines the previous year's growth.

General tree vigor can be determined by measuring several twigs over three to four years. Twig growth on most young trees is usually nine to twelve inches or more per year. Larger, mature trees may grow only four to six inches per year. If growth is less than this, considering all other factors are average (such as a no drought year), the tree may need fertilizer.

Benefits of Fertilizer

Fertilizer can improve the overall vigor of a tree. It makes the leaves grow larger and become a darker, green color. It encourages rapid development of young trees and maintains continued health of landscape plants. A vigorously growing tree or shrub is less susceptible to certain pests and diseases. If trees are already in an unhealthy state, fertilizer prevents them from declining further. Mature trees need little or no fertilizer unless they are showing signs of poor nutrition. As long as they show normal leaf color and reasonably adequate growth, they need very little fertilizer.

Three Types of Fertilizers

There are three basic types of fertilizer: dry, liquid, and organic.

Dry fertilizers - Dry fertilizers come in granular, pellet, and powder forms. These are the easiest fertilizers to apply. They can be sprinkled on the ground and watered in, cultivated into the soil, or buried at the root zone.

Some dry fertilizers are soluble in water and can be applied as a liquid. This form is readily absorbed by plants, but also leaches from the soil in a matter of two to three weeks.

Other dry fertilizers are insoluble in water and dissolve over a longer period of time. These are called slow-release fertilizers and are usually more expensive than water-soluble fertilizers. They can last from six weeks to two years depending on the type. Urea formaldehyde is a popular form of slow-release fertilizer. However, bacteria is needed in the soil to slowly break it down into a usable form. Plant tablets are another form of slow-release fertilizer.

A fertilizer bag will list the amount of soluble and insoluble fertilizer it contains. A 20 percent nitrogen fertilizer may have 18 percent soluble and 2 percent insoluble fertilizer.

Liquid fertilizers - Liquid fertilizers can be applied through a hose siphon, drip irrigation, root irrigation, or as a foliar feed. They are purchased in either a powder or liquid concentrate form that must be diluted in water. These are effective ways to fertilize container-grown plants or plants that need frequent, light fertilization.

Organic fertilizers - Organic fertilizers are natural fertilizers obtained from plants or animals. Manure, compost, blood meal, fish meal, and bone meal are all organic fertilizers. Fish emulsion is a liquid form of organic fertilizer; the rest are dry. Organic fertilizers, such as manure, improve the soil structure as well as supply nutrients. They last a long time in the soil, but they tend to be a bit more expensive and bulky to work with.

Fertilizer Application Methods

When fertilizing trees, the entire area occupied by the root system should be fertilized. This area consists of the soil directly beneath the branch spread and slightly beyond. There are several methods of applying fertilizer.
1. Surface application
2. Soil incorporation (dry or in solution)
3. Foliar sprays
4. Others; such as fertilizer spikes, and slow-release pellets.

The equipment available, slope of soil surface, other plants in the area, and the species of tree; will determine the method that should be used.

Surface application method - Surface application method is the easiest to use. This method uses a dry, granular fertlizer. Since phosphorous and potassium move slowly through the soil to tree roots, they are not included in a surface application of fertilizer; only nitrogen is applied. In this method, a square or rectangular area that includes the entire branch spread of the tree is staked off. The square feet of the square or rectangle is determined by multiplying the length times the width. Six pounds of nitrogen should be applied annually per 1000 square feet of tree root area. Three separate applications should be made since this amount of nitrogen, applied at one time, would kill any grass growing under the tree. Application times should be in spring (March or April), and in early fall (mid-to late September), and four to six weeks later (mid-to late October). No more than two pounds of nitrogen should be applied at one time to avoid plant injury. If the lawn under the tree has recently been fertilized, subtract the amount of nitrogen already applied from the amount needed for the tree.

If using urea formaldehyde (slow-release), up to three pounds of nitrogen can be applied without plant damage. Two applications, one each in spring and fall, should be made.

A surface application of fertilizer is made with a lawn fertilizer spreader or broadcast by hand over the designated area. The area should then be watered to wash the fertilizer off the grass. Thorough waterings help move the fertilizer down to the root zone.

Soil incorporation method - Dry fertilizers can also be incorporated into the soil by drilling holes in the soil around the tree. The advantage of this method is that the tree roots can be fertilized without affecting the grass growing under the tree. The area should extend slightly beyond the branch spread of the tree. Thoroughly soak the soil the day before fertilizing. Using an iron rod or a soil auger, make holes in the soil 12 to 15 inches deep and two feet apart in concentric circles around the tree, staying two feet away from the trunk. Ten to 15 holes should be made for every inch of trunk diameter. Pour one-fourth to one-half cup of fertilizer into each hole. Sand, pea gravel, or peat moss can be mixed with the fertilizer to improve soil aeration. The area should be thoroughly soaked afterwards.

To determine the amount of fertilizer to be used, measure the trunk diameter of the tree four and one-half feet from the ground. For trees six inches or less in diameter, one to two pounds of a complete fertilizer per year for each inch of trunk diameter. For trees with trunks more than six inches in diameter, two to four pounds of fertilizer per year should be applied. If a fertilizer contains less than 15 percent nitrogen, the higher rates listed on the label should be used. If a fertilizer contains more than 15 percent nitrogen then the lower rates listed on the label should be used.

When fertilizing trees, a complete fertilizer should be used. Since trees suffer more from nitrogen deficiency than any other nutrient, a fertilizer with a 2-1-1 or a 3-1-1 ratio should be used. The more commonly used fertilizers are 12-6-6, 10-6-4, 10-8-6, and 10-8-4.

If a tree's branch spread area is under pavement, the amount of fertilizer should be adjusted according to the amount of area covered. The amount should also be adjusted to compensate for trees grouped together. For example, if half of the area is under pavement, use half the amount of fertilizer.

Liquid fertilizers can be injected into the root zone by root irrigators. At the same time the tree is being irrigated with this method, the fertilizer is applied down to the level of the roots.

Foliar spray method - Foliar sprays are used to quickly overcome a deficiency. However, they are used for short-term remedy only; they are not a cure. This is because if the nutrients are applied to the soil they will become unavailable to the plant roots due to the pH of the soil. As mentioned before, some nutrients become tied up in the soil if the pH is too high or low. The reverse can also happen; a nutrient can become toxic to plant roots if the pH is too low or high. In the foliar spray method, the fertilizer is sprayed on the leaves of the plant and absorbed through them. Iron chlorosis is commonly treated with foliar sprays of iron chelate. This method of fertilization tends to be expensive because of the concentration of the nutrient and the frequency of application.

Other methods - Other methods commonly used for their convenience are tree spikes and slow-release pellets. They also may be expensive, but are easy to use. Always follow directions on the package.

When to Fertilize

The time to fertilize depends on nutrients needed, formulation of fertilizer, method of fertilization, climate, and plant nutrient levels. Fertilzation should be done when plants most need it. In Missouri, the best time is in the spring when the trees are rapidly growing.

Nitrogen should be applied when the plant is still dormant; about two weeks before spring growth begins. It should be applied yearly. If fertilization is done in mid-growing season, moderate amounts should be used. Trees and shrubs should not be fertilized late in the growing season, because a flush of new growth will occur which will be susceptible to winter injury. Besides this detrimental reason; the trees will have better fall color if they do not have high levels of nitrogen.

Foliar sprays of iron, zinc, and manganese should be applied just after a few leaves reach mature size. Repeat applications as necessary.

Rapidly growing trees should be fertilized yearly, while mature trees may not need yearly applications. Every other year should be enough. This depends on the tree. Newly-planted trees should not be fertilized until they are well-established (usually after the first growing season). A starter fertilizer may be used when planting, but a high-analysis, granular fertilizer should not be used.

Estimating Fertilizer Cost

When determining a landscape maintenance budget, or which fertilizer to buy; it is important to know how to figure the cost of fertilizer nutrients. Fertilizers can be purchased in many different formulations and mixtures. They vary according to the percentage of nutrient per weight and also in price.

First it must be decided how much fertilizer is needed. The amount of nutrients to be applied, the size of the area to be covered, and how many plants the fertilizer will cover; should be carefully considered. The following equation will be helpful.

> (A)-Area needs to be determined first. It is usually easier to work with square feet. When figuring the area under a tree or shrub, figure the radius from the trunk to the drip line (The drip line is the imaginary circle at the outermost point of the plant where water would drip off the plant).
>
> (R)-Rate of application should be a given rate. This is usually pound per 1,000 square feet.
>
> (N)-Nutrient analysis will give the percentage of the specific ingredient needed. This will be represented as pounds of active ingredient per 100 pounds of fertilizer. Trees and shrubs generally use a balanced fertilizer, but many times nitrogen is the nutrient that is considered when figuring the amount to be used.
>
> Example:

$$\underset{\text{(A)rea}}{400\text{ sq. ft.}} \times \underset{\text{(R)ate}}{\frac{1\text{ lb. N}}{1{,}000\text{ sq. ft.}}} \times \underset{\text{(N)utrient analysis}}{\frac{100\text{ lbs. fert.}}{10\text{ lbs. of N}}} = 4\text{ lbs. of fert.}$$

N = Nitrogen

Cost: 4 pounds of fertilizer x cost per pound = cost

Summary

In order to fertilize a plant that is deficient, landscapers must first know the effect the nutrient has on the plant and its deficiency symptoms. They must also know how to choose a fertilizer and be able to read the fertilizer bag to know if it contains what is needed. They must then know how and when to apply the fertilizer. Finally, landscapers must know how to figure the cost of the fertilizer so they can know what amount to charge the client.

Credits

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GO6865	Fertilizing Shade Trees
GO9109	Submitting a Soil Sample for Testing
GO9110	How to Get a Good Soil Sample
GO9111	Using Your Soil Test Results

Table 4.1 - Nutrients' Roles and Deficiency Symptoms

NAME	ROLE OF NUTRIENT	DEFICIENCY SYMPTOMS
Phosphorus (P)	promotes root formation; stimulates cell division; essential to carbohydrate transfer; stimulates blooming; promotes maturation; promotes disease resistance	red or purplish discoloration of older leaves, stems, and branches; thin shoots or stems, small leaves; slow growth and maturity; stunting of growth; premature leaf drop
Potassium (K)	essential to the formation and transfer of starches, oils, and sugars; promotes enzyme activation; promotes plant vigor and disease resistance	mottling, spotting, streaking of leaves, or curling of lower leaves; leaf margins and tips scorched.; burning at tip of leaf, proceeding downward
Nitrogen (N)	important to synthesis and structure of protein molecules; necessary for chlorophyll manufacturing; induces rapid vegetative growth; produces a healthy green color	a sickly yellow-green color; a distinct slow and stunted growth; chlorosis (burning) first noticed in older leaves, starting at the base of the leaves and working down to the midrib; increased fall color
Sulphur (S)	promotes root growth; essential to protein formation; encourages a more vigorous growth	younger leaves are light-green in color; the veins are even lighter; stalks are short and slender; overall plant growth slow and stunted
Calcium (Ca)	a component of the cell wall; needed for cell division; influences absorption of other nutrients; improves general plant vigor; promotes early root formation and growth	stems, leaves, and roots die at tips where normally active; young leaves show chlorosis then necrosis at margins; tips hooked back; roots are short and branched; shows symptoms of other nutrient deficiencies since it influences their absorption; leaves with wrinkled appearance
Magnesium (Mg)	aids in transport of phophorous; essential for photosynthesis; aids in translocation of starches; influences absorption of other plant nutrients	interveinal chlorosis starting at oldest leaves moving up stalk; veins remaining green; leaves mottled; plant stem slender and weak; leaf tips turned or cupped upward; leaves thin, brittle, and drop early
Iron (Fe)	essential to chlorophyll production; acts as an electron carrier in enzyme systems that cause oxidation to occur	net-like interveinal chlorosis of young leaves; followed by mottled, browning, short, and slender stalks
Boron (B)	aids in translocation of sugar; influences water absorption	leaves small, thick, brittle, and curled; young leaves light green at base, scorched, bronze or red color; stunted roots; petioles or stems cracked and brown inside

NAME	ROLE OF NUTRIENT	DEFICIENCY SYMPTOMS
Manganese (Mn)	essential in making nitrogen available to plants; activates enzymes in metabolism	interveinal chlorosis with wide band of green along vein (checkered effect); spots of dead tissue scattered over leaves; leaves limp and curled
Copper (Cu)	involved in plant respiration; aids in utilizing iron needed for photosynthesis; needed for synthesis of enzymes	young leaves permanently wilted; leaves spotted near tip; stem below seed head becomes weak
Zinc (Zn)	important in synthesis of plant hormones; important to protein synthesis; important to plant metabolism; involved in reproduction processes of certain plants	leaves thick, small, pointed, and narrow; shows necrotic spots on uniformly yellow leaves; internodes short
Molybdenum (Mo)	makes nitrogen available to plant; essential to plant development and reproduction; essential to enzyme synthesis; requires presence of other micronutrients	leaves scorched; marginal necrosis and rolling with reduced width; shows signs of nitrogen deficiency (sickly, yellow-green color); severe internodes; short flowers, few and small
Chlorine (Cl)	affects root growth but little more is known about its effect on plants; more likely to be toxic than deficient	N/A

The successful maintenance of trees and shrubs in a landscape depends greatly on use of proper irrigation and drainage. The landscaper must be aware of factors affecting watering rate, various watering requirements, and types of irrigation systems that may be used on trees and shrubs.

Factors Affecting Rate of Watering

The frequency of irrigation cannot be set by a calendar. It is affected by variations in the weather (temperature, wind, humidity, and hours of sunlight), time and amount of the last rain, the depth and spread of the root system, the type of soil, and the size of the top of the plant. These factors affect the amount of water that the plant is using and how often it will need irrigation. The individual requirements and the age of the plant also play a part. Some plants prefer a lot more moisture than others, and younger trees and shrubs require more water than more established ones. Areas where the soil surface is restricted or where high temperatures are built up; such as around driveways, walls, curbs and patios; require more frequent watering.

Weather - The weather (temperature, wind, humidity, and hours of radiation) have a definite effect on the irrigation needs of plants. Review Unit II, Lesson 3 to understand why a plant needs more water under hot, windy, or low-humidity conditions, or long hours of sunlight; than if the weather is cool, calm, humid, and cloudy.

Rainfall - It is obvious that the time and amount of rainfall affects irrigation. If the last rain was a mere sprinkle three weeks ago, and the weather has been hot and windy since, the plant probably needs irrigation.

Root system - A deep, wide, spreading root system has more opportunity to absorb water than a shallow root system. The shallow root system has only the top three feet of soil to draw water from, even though water may be available deeper down. Therefore, it will need irrigation more often. A shallow root system is the result of shallow watering. It is advantageous to have a deep root system. If the top three feet of soil is dry, the roots deeper down can absorb water to support the tree. Many trees together require more water than a single tree. The roots complete for available moisture.

Soil type - The type of soil can be a strong determinate of irrigation practices. Apply knowledge about soils from Unit II, Lesson 2. A sandy soil holds less water than a clay soil. Also, water will move through a sandy soil more quickly than a clay soil. Plants can absorb water from the soil when it is between the field capacity and the wilting point. Water rarely moves sideways. Where it is applied on top of the soil is where it will filter through.

Watering practices - The best watering practices include watering the plant thoroughly, but infrequently. This is much better than frequent, light watering; which will cause shallow roots. It is also better than frequent, deep watering; which will waterlog the roots. There must be a good water/air relationship for roots to grow well. A scheduled watering time, such as once a week, may leach nutrients and drown the roots. A thorough watering will fill the soil to field capacity. Allow the soil to dry out (no lower than the wilting point).

The visual plant symptoms that indicate a plant is deficient in water are: very few healthy, bright-colored roots; the leaves will wilt and turn a dark, grayish-green color with a purplish tinge; the edges of the leaves die, turn brown, and fall off; and the shoot growth is reduced. Some similar symptoms tell if the tree has been overwatered. These are: the leaves wilt and fall off; no marginal necrosis occurs; the leaves instead turn a light color; the new growth looks chlorotic; the shoot growth is reduced; instead of having light-colored roots they become dark and spongy; and soil usually smells sour.

The leaves lose water by transpiration and the soil loses water by evaporation. Evapotranspiration is the term for these two together. The evapotranspiration rate, and knowing the amount of moisture available in the soil, can be used to determine how often and how much to water. A tensiometer can be used to measure and read the amount of moisture in the soil. The soil can be tested by getting a representative sample from the area.

Watering Requirements of Established Versus Newly-Planted Trees and Shrubs

The basis for the difference in watering requirements between established and newly-transplanted trees and shrubs is primarily the root system. The root systems of newly-transplanted trees are very limited and in a limited amount of soil. The roots of young trees are more tender and cannot endure drying out like older, more established roots. The roots of established trees are more extensive and reach farther down into the soil to absorb moisture.

Irrigation Systems

The irrigation systems used for landscape trees and shrubs are dishes or berms, furrows, sprinklers, drip/trickle irrigation, and root irrigators. The main objectives of these methods are: to provide water slowly enough that it soaks into the ground instead of running off; to keep the water inside the drip line of the tree (where most of the roots are); and to apply the water uniformly. As much of the applied water as possible should go to the tree.

Dish or berm - Dish or berm irrigation is used for newly-transplanted trees. See Figure 5.1. It is best used on level areas. The dish should be as wide as the drip line of the canopy. Water is applied slowly to the inside of the dish by a slow, trickling, hose; a soaker; or built-in bubblers. Water should not rest against the trunk.

Furrow - Furrow irrigation can be used along a row or group of trees. See Figure 5.2. The furrows are dug on either side of the row of trees and should be three to eight inches deep. The area should be level with enough slope for the water to pass slowly from the upper end to the lower end. Enough water should be applied to flood the end quickly. Then the amount should be reduced. This should work so that the last of the water applied, is soaked in just as it reaches the end of the furrow. This should allow the least amount of erosion and leaching of nutrients. Salts may accumulate at the top of the ridges.

Figure 5.1 - Dish Irrigation

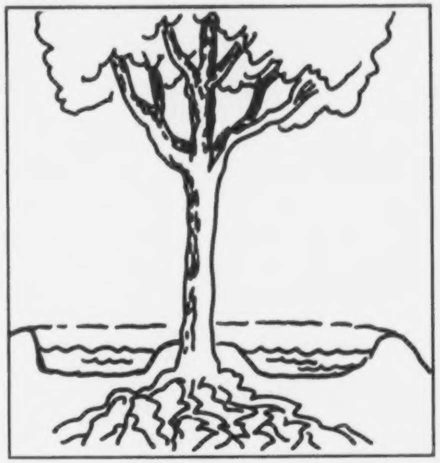
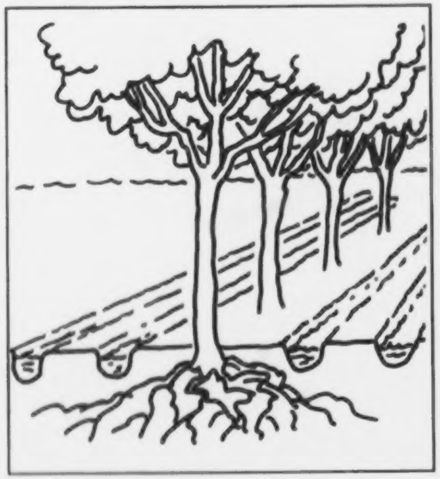
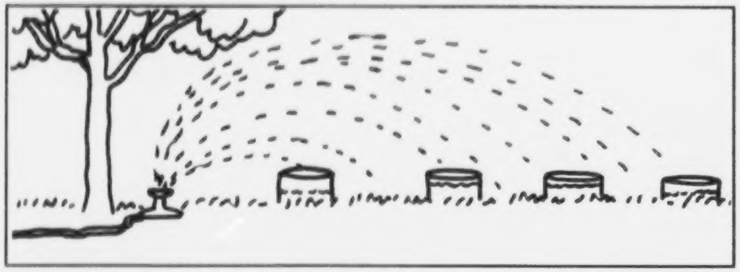


Figure 5.2 - Furrows



Sprinklers - Sprinkler irrigation is popular and easy to set up. The uniformity of the sprinkler depends on the system. Sometimes corners can be missed. Sprinklers often apply water faster than the ground can absorb it. A change in the sprinkler can overcome this problem. Wind can also affect the distribution. Sprinkler irrigation can compact bare soils and reduce infiltration. The weight of the water can damage flowers in the area and knock them down. Chemicals in the water may cause leaf scorch. Salt may build up on the leaves, which is unattractive. Sprinklers are best used on level areas. It is also best to use sprinklers early in the day when the wind is not strong and the foliage will dry more quickly; otherwise, rust and mildew diseases will break out. To determine how much water is applied to an area by a sprinkler, place several, uniform-sized containers with wide, straight, sides evenly around the sprinkler pattern. Turn on the water for one hour. After one hour, measure the depth of the water, in inches, in each container. Add the depths together and divide by the number of containers. The result will be the average amount of water applied in one hour. This will also allow you to know if the sprinkler is working properly. See Figure 5.3.

Figure 5.3 - Sprinkler



Drip irrigation - Drip irrigation helps cut the waste of water when irrigating. This system delivers a small amount of water at a time to individual plants. Very little water is wasted by runoff. The distribution of drip irrigation is very uniform. Also, the plant itself stays dry. To drip irrigate, lay a perforated hose on the soil around the drip line of the plant so it will soak the plant roots. This method takes longer but wastes little water. It can be used on slopes.

Root irrigator - A root irrigator is good for sloping areas. Attach the hose to a tube that is inserted 12" to 18" in the ground. Water comes out through holes near the tip of the tube right where the roots are located. Fertilizer can also be applied this way.

Irrigation in Landscape Planters

Soil - The soil used in a landscape planter is very important. It should not only provide anchorage, but it should drain rapidly. The texture and depth will determine the amount of water that will remain after the excess water drains off. The biggest problem in a container planting is the soil remaining wet too long. A mix of 50% coarse sand and 50% organic material is a good mix.

Irrigation system - A container planting that has a self-contained irrigation system cuts down on maintenance cost a great deal. This system should help support the container. An automatic system that has a low application rate will cut down on overwatering and water waste.

Drainage system - The container should have a drainage system that will handle the maximum amount of extra water. The bottom of the container should have a slight slope, two percent, to lead the extra water to the drain tile. The soil should drain rapidly to the bottom of the container, through the drain tiles, and into the street drainage. A one inch plastic pipe can be used as a drain tile. This adds little additional weight to the container. The pipe should be wrapped in a fiberglass filter to keep silt from clogging it.

Summary

Many factors that determine the water usage of a tree or shrub must be carefully evaluated before irrigating. The environment, climate, number of plants in the area, type of plants season of the year, the soil texture, age of the plant, and type of root system must all be considered. Then the frequency and type of irrigation system can be chosen.

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Insects and diseases occur naturally in the environment. Some are beneficial and some destructive. Destructive insects and diseases cannot be eliminated completely, but some can be controlled in order to save a plant's appearance or value.

Insects and Control

Table 6.1 (located at the end of this lesson) lists some of the most common destructive insects, and their damage or symptoms.

Stages of development - As discussed in Unit V, insects go through metamorphosis. Their stages of development and their means of eating must be known before the insects can be controlled. Insects may be controlled by different methods in each developmental stage. A method may work in one stage but not the next.

Feeding methods - The mouth parts of an insect determine how the insect feeds on the plant, and the type of plant damage that results.

1. Chewing - The insect can tear or chew the plant tissue. Examples are; grasshoppers, bagworms, and cutworms.
2. Rasping-sucking - The insect is able to chew on the plant and then sucks the liquid up through a tube. Examples are bees, wasps, and thrips.
3. Piercing-sucking - The insect pierces the plant tissue with its tube-like mouth and then sucks up the liquid. Examples are aphids, scales, mosquitoes, horseflies, and spider mites.

Insect control - There are several different control methods for insect pests. Mechanical control includes any type of control that does not use pesticides, systemics, other insects, trap crops, or chemicals. It includes hand picking, fences, and mouse traps; to name a few.

Trap crops can be used as a biological control method. A crop the insect prefers feeding on is planted near the desired crop. The insects are attracted to the trap crop and do not feed as much on the desired crop.

Radiation is used to sterilize adult males so they cannot fertilize eggs.

Beneficial insects which are natural enemies of pests, and do not bother the crop, are brought in to feed on the pests. Lady beetles and preying mantis' are examples of these.

A chemical can be applied to kill insects at an immature stage of development. This interrupts the life cycle and does not allow them to mature and reproduce.

Systemic insecticides affect insects that feed on plant parts or plant juices. Landscapers apply these insecticides to the soil or on the plant parts; it is taken up by the plant roots in the fluids. When the insect feeds on the plant, the poisonous juices kill it.

Contact poisons are sprayed directly on the insect, killing it. Insects with a hard outer shell may be difficult to kill by this method.

Stomach poisons are sprayed directly onto the plant parts. When the insect feeds on the plant, it is poisoned.

Diseases and Their Control

Causes of disease - A plant can be injured by a disease. Table 6.2 (located at the end of this lesson) lists some of the most common diseases. Pathogens that live on the plants (hosts) cause disease. Pathogens are bacteria, fungi, viruses, and nematodes. They are microscopic in size and multiply in high numbers. A pathogen must be in a form that will grow when transferred to the host plant or in its infectious form of inoculation. The host may be present at any stage of its life. The environmental conditions must be right for the pathogen to contact its host.

Dissemination - Pathogens can be carried to their host plant by the following agents of dissemination: insects, splashing water, wind, animals (humans, too), equipment, and tools. Pathogens in their infectious forms are fungi spores, a virus particle, strand of hyphae, and bacterial ooze.

Sites of infection - The pathogen can enter the plant at the sites of infection, which are stomata, cuts, wounds, blossoms, roots, and fruits.

Symptoms - Symptoms are the effects of diseases on plants. Some of the most common symptoms on trees and shrubs are wilting, color changes, rotting, tissue death, dwarfing, increase in size (from malformed parts), tunneling, and holes.

Disease control - There are thousands of pesticide products that can be used to control insects and diseases. These change over time, but the principles behind pest control remain the same and can be applied to any insect or disease.

Pest control is desirable to reduce damage to plants. The damage plants receive from an injurious pest is either qualitative or quantitative. Qualitative damage results in the plant's loss of healthy appearance and its sale value. The damage lowers the general plant quality. Quantitative damage results in the loss of the plant or its parts.

Degrees of control - There are three degrees of control that a landscaper may choose in controlling the pest. These are partial, absolute, and profitable degrees of control. Partial control can be achieved by eliminating most but not all pests. The plant may still show signs of a pest, but not as severely or damaging as before. This is the most common degree of control. Absolute control or eradication involves complete removal of the pest, so the plant shows no sign of damage. This is costly, time-consuming, and better suited to nonbusiness purposes. Growers often use profitable control. This is done if the benefits outweigh the cost of control. If the profit of a crop of bedding plants is worth more than the cost to control pests, the grower will benefit by spraying or using other control methods.

Type and method of control - The type and method of control should be considered thoroughly before beginning treatment. Factors such as the effect the control will have on the environment, and the success of the method, play a big role.

Prevention - The first type of control is prevention, which involves keeping the pest from ever becoming a problem. This type of control is achieved by using several methods. The use of pest-free stock, certified seeds, and resistant varieties, prevent pests from infesting plants. Also, certain cultural practices, sanitation, and plant quarantines can prevent disease. Preventative applications of chemical pesticides can also be used.

Suppression - Suppression is a type of control that is used when pests have already invaded the plant. The control methods used in suppression reduce pest numbers to an acceptable level. Cultural practices include: sanitation; modifying moisture levels to avoid prolonged periods of high moisture; modifying pH so that it is more favorable to the host and not the pest; and modifying the nutrient level to a favorable level for the host. A healthy, actively-growing plant is less susceptible to pests than a poorly-growing one. Chemical pesticides and biological control methods also suppress pests.

Eradication - Eradication is the type of control that completely destroys or removes pests from a crop. This is an extreme measure in commercial horticulture. Eradication measures are usually too costly to carry out on a large scale. Eradication methods are hand pulling weeds and cultivation, destruction of an alternate host (such as in cedar apple rust disease), crop rotation, and soil treatment. Other methods are destroying infected host parts, removing rotting materials, and isolation or destruction of the individual plant host. Chemical pesticides can also be used.

Noninfectious Disorders

Plants in landscape situations are exposed to many destructive disorders that are not related to insects or diseases. These are called noninfectious disorders. Many times these disorders are caused by soil or root problems; but they may also be caused by vandalism, drought, girdling, animals, landfill gases, weather, pollution, or herbicides.

Soil and root problems - Many noninfectious disorders arise from soil or root problems. When pavement or fill soil is placed over existing soil under the plant's drip line, it can prevent either water or air from penetrating the soil. This suffocates the roots and causes the tree to die prematurely. Gases in the soil, caused by decomposition of landfill material, can kill trees and shrub roots. On occasion, more sensitive plants can be killed by a natural gas leak. During construction or repair of drains or utility lines, the roots are often dug up around a part of a plant. This disturbance of the roots can lead to death of the plant.

Drought can cause the decline or death of a plant. Drought occurs not only from lack of rain; but also from frozen earth, injured or diseased roots, or hot weather that causes the roots not to keep up with the amount of water lost by transpiration. This causes wilting and leaf scorch. Death of a tree can occur by girdling of the roots. This happens when the roots are circling the trunk or the main roots, cutting off the nutrient and water supply. Animals such as gophers, moles, or mice can burrow into the roots or tunnel into tree trunks; causing damage. Larger grazing animals feed on the bark in sparse winters, causing girdling. These disorders can lead to plant death.

Weather - Weather can cause problems in plants, if it is severe. Temperature or moisture in excess or deficient amounts can cause death to trees and shrubs.

Air quality - Unit II, Lesson 3 discusses problems of poor air quality or pollution.

Chemical injury - Herbicides sprayed on lawns to remove weeds, can sometimes drift onto trees and shrubs, or be misapplied causing malformed leaves or more severe damage. Salts applied to sidewalks in winter or salts from over-fertilization; may cause the growth of trees and shrubs to slow down; or, in severe cases, may cause death.

Mechanical injury - Trees and shrubs receive a significant amount of mechanical damage in the landscape. Automobiles, lawn mowers, or bicycles may hit the trunk of a tree; causing damage to the bark. Trees may be vandalized by someone hitting, slicing, or bending them. Cutting the tops of coniferous evergreens, which may occur around Christmas, can result in destruction of the tree. Winter can bring heavy snow loads or ice coverage that can break the branches of deciduous and evergreen trees. Staking and guying may cause damage, if it is done incorrectly. Girdling can occur if the guys are left on too long or if they rub against the tree.

Biological Control

Biological control is the oldest method of pest control today. Biological control uses all "natural" methods of control; no synthetic, only organic substances are used. The natural pest enemies cut down the pest population.

Every pest has its own natural predator whether it is an insect, a disease pathogen, a bird, or an animal. They all seem to keep their prey's population under control. Large specialized farms knocked the ecosystem out of balance. The pest population that preferred a certain crop for feeding outnumbered the predators. Chemicals were introduced to control these pests. Unfortunately, the chemicals killed both good and bad insects.

There are many problems with chemical use. Chemicals are very poisonous; not only to the insects, but to animals and humans, as well. Chemicals do not actually work as effectively over time. Insects become resistant to chemicals. After awhile, they change or mutate to avoid the chemical effects. Therefore, another chemical must be used to control the now resistant insect. Insects cannot become resistant to their natural enemies.

Natural enemies - Some examples of insects used for natural control are the preying mantis and the lady beetle. Another is a tiny wasp that lays its eggs inside an alfalfa weevil. The eggs hatch and the larvae eat the weevil from the inside out.

If a natural enemy is not in the area, it can be introduced. Some natural enemies are mass-produced in laboratories and then brought to a location where they are needed.

Other methods - Some other biological control methods are the use of disease- and insect-resistant plants, crop rotation, and natural pesticides. Natural pesticides are chemicals taken from plants such as marigolds, chrysanthemums, or basil. Pyrethroids and rotenone are two examples. Hand picking, where only a few insects are present, is effective. Crop rotation controls insects that do not move rapidly from location to location. Crop rotation also can control soil-borne diseases. New microbe strains to combat plant diseases and some insects have recently been produced, and will help in the future.

Improper application of chemicals can damage the environment. Fewer chemicals are now available because of EPA restrictions. Also, insects are becoming resistant to the remaining, available ones. Biological control should be the first step practiced in controlling any pest. With the present trends, it may be the only step available in the future.

Summary

Insects and diseases can destroy trees and shrubs if they are not controlled. While complete eradication is not feasible, controlling enough to prevent economic loss is. The type of insect or disease must first be identified, then proper methods to control it can be taken. While it is popular to use chemical pesticides, they are found dangerous to people, and the environment. Biological control should be used whenever possible.

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Table 6.1 - Common Insects

NAME	DESCRIPTION	TYPE OF DAMAGE	SYMPTOMS	CONTROL
Elm Leaf Beetle	adult-black, with yellow stripes, 1/4"	eats the leaf tissue leaving only the veins	brown foliage, defoliation of tree	Check for larvae in early June. Spray when present. Check again in late July.
Borer	creamy white, 1/2"-1 3/4"	circle (ground) the tree under the bark, eventually girdling and killing it	amber clump of sap near the entry or exit hole, the hole can be near the gound or by first branch	Avoid mechanical injury. A preventative: wrap trunk with heavy paper. Use preventative trunk spray or control with 3 sprays a year.
Spider Mites, *not a true insect	yellow, brown or red, 1/60"	piercing-sucking, suck sap from leaves	yellow mottling of leaves, underside of leaf, thin webs sometimes present	Syringe leaves with water. Spray or use systemic.
Mealy Bugs	white cottony mass, 1/8"	found at leaf axis, leave sticky residue, sucking	suck juices and stunt growth	Home - touch with alcohol soaked cotton. Spray or use systemic.
Aphids	light-green, yellow, white, black or brown, 1/8-1/5", winged or not, soft bodied	suck sap from plants	found at flower buds and new growth, shriveled leaves secrete honey dew on which sooty mold grows	Spray when present.
Scale	hard brown disc on plants	piercing-sucking, weakens plant making it more susceptible to other problems	stunted growth	Control is difficult. Spray dormant oils. Systemic pesticides can also be used.
Lace Bug	lacy-winged on underside of leaf, brown to black-gray, 1/8"	mottle and discolor leaves, yellow specks, piercing-sucking, black insect droppings on underside of leaves	mottled, yellow-speckled leaves	Spray when noted on leaves.

NAME	DESCRIPTION	TYPE OF DAMAGE	SYMPTOMS	CONTROL
Leaf Miner	whitish larvae of sawfly 1/4"	tunnels between leaf surfaces	yellow, tunneling lines in leaves	Spray late May, second application in late June.
Bag Worm	cased in a brown pouch on leaf, pieces, 1-2" long case, brownish larvae inside	chew leaves	chewed leaves	Spray in early June while larvae are small. Picking them off may not always work.
Leaf Hopper	small, elongated, greenish-whitish, jumping	suck sap from leaves	spots on leaves	Spray when in damaging numbers.
European Elm Bark Beetle	white, legless larvae	over winters in or under bark of recently killed and dying elms, adults emerge April and August, carry Dutch Elm Disease	wilting and yellowing of leaves on one or more branches, leaves fall prematurely	For sanitation, keep dead wood of tree and burn. Spray high value trees (no known cure).
Thrip	small, elongated body	cause death of unopened flowers, sucking juices	leaf streaks; (spread virus)	Use systemic spray.
Caterpillers	larvae of butterflies and moths, 1/2-2" many varieties	chew leaves, cause brown color	defoliated tree	Use contact spray.
Whiteflies	small wedge-shaped, has wings, hides on underside of leaf	sucks juices from plant on underside of leaves		Spray when visible.

Table 6.2 - Common Diseases

DISEASE NAME	COMMON HOST PLANT	SYMPTOM	DAMAGE	CONTROL
Powdery Mildew	lilac, roses, zinnia, crepe, myrtle	white or gray leaves	leaves distorted	Provide good air circulation. Use chemical spray. Reduce humidity. Thin plants.
Fire Blight	Pears, quince, pyracantha, apple	leaves and new growth are black shoots that die back from tip, dead leaves cling to branch	leaves and branch die back into tree, new growth has "shepards hook"	Select resistant varieties. Remove dead parts and sanitize tools between cuts. Spray chemical pesticide before infestation occurs.
Black Spot	roses	small or large spots up to one-half inch on upper surface of the leaf, centers of holes can fall out, common during rainy season	holes in leaves can defoliate plant	Remove and burn infected leaves. Clean culture. Spray to prevent and treat.
Dutch Elm Disease	American and other elms	leaves wilt, turn yellow then brown, branches then die	leaves die, tree dies	Cut and remove diseased trees. To prevent others from getting it; spray annually with insecticide, fungicide, or systemic.
Anthracnose	sycamore, sweet gum, oak, red bud, elm, dogwood	spots on leaves between veins, dark-purple to brown margins, common in wet conditions	die back, early leaf drop	Prune diseased protion. Remove dead leaves from ground. It is usually not serious enough for fungicide spray unless very wet.
Verticillium Wilt	honeysuckle, catalpa, maple	leaves turn yellow and wilt, shrivel on one or more limbs, mid-summer brown streaks on sap wood	sudden death of plant	Cut and remove severely wilted trees. If one to six limbs are affected, trim affected parts and disinfect tools after each cut. Fertilize heavily in early spring to encourage vigorous growth.

DISEASE NAME	COMMON HOST PLANT	SYMPTOM	DAMAGE	CONTROL
Rust	hawthorn, crab apple, green bean	pale-yellow-orange, spots - resemble rust, "cluster-cups" on underside of leaf, swollen distorted gall-like formation on leaves and twigs	spots, does little damage	Provide good ventilation. Avoid water on leaves. Remove infected parts. Separate alternate host (cedar) one-half mile. Follow apply spray schedule.
Canker		swelling at ground level or base of stems or limbs	branch out from canker dies, causes girdling and death of plant	Prune and remove infected parts. Avoid wounding plant. Control insects. Fertilize and water to promote vigor. Treat pruned area with tree paint.
Blight	junipers - many others	shoots turn brown, scattered throughout plant, common and severe in wet spring, spots on leaves	shoots die back	Prune annually for good air circulation. Remove affected parts. Avoid over-fertilization. Control borers.
Crown Gall	rose, oak, enonymus	small to large, rough galls on roots, crown and canes, tumor-like growth	unsightly, plant will decline in health	Use certified disease-free stock. Carefully remove and destroy affected parts; avoid wounding. Use strict sanitation. Paint over gall to dry it up.
Botrytis Grey Mold	flowers and stems of many plants	blackened soft decay	destroyed flowers	Reduce humidity. Remove decayed parts (common in wet conditions). Use chemical spray before, during, and after bloom.

Bedding plants are one of the showiest groups of plants in the landscape. Without proper installation; most importantly, soil preparation and spacing; their potential for a showy design can instead be a drab display of unhealthy plants, that are either too far apart or too close together.

Preparing the Soil

When planting bedding plants and ground covers, the whole area to be planted is prepared instead of each individual hole. If planting ground covers on a slope, individual pockets should be prepared. If the whole slope is prepared, erosion can occur in only one or two rains.

A soil test should be taken before any amending is done to the soil. The soil should also be weed free.

The success of planting bedding plants depends on how well the soil is prepared. It is beneficial to add organic matter to the soil. A good mix includes at least one third of the final mix as organic matter. Spread peat moss, compost, and manure two inches thick over the soil. If the soil test shows the pH needs to be changed, it may be altered with lime to lower it or sulphur to raise it. This along with a complete fertilizer (5-10-5), two to three pounds per 100 square feet, can be added at time of soil preparation.

The organic matter, lime or sulphur, and fertilizer should all be worked into the top six inches of the soil. This can be done with a spade. Stick the spade in the soil and turn the soil over, breaking up any large clumps. For larger areas, a rototiller works well. Next, rake the soil so it is smooth.

Transplanting

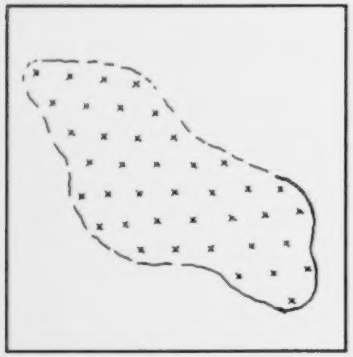
Ground temperature - Before planting, be sure the ground temperature is warm enough for the plants. For tender annuals, two weeks past the last frost should be warm enough. This may vary. Hardy annuals can be planted earlier. Check the cultural requirements of each species.

Spacing - Spacing of the plants should be determined before planting begins in order to have the correct number of plants on hand. Spacing guidelines are frequently found on the seed packets or on the plant label. Tables in Unit X, lessons 3 and 4 will show the spacing requirements for the plants studied in this course. Spacing depends on the plant variety and its growth habits. Spacing closer together allows a quicker fill-in time, but it is more expensive since more plants are needed. Close spacing can increase the chance for disease, as well, since there is little air movement.

When planting ground covers, the location of the planting may determine the spacing. If planting in a highly visible area, such as near the front door of a house; one may not want to wait two years for it to fill in, so spacing closer together is an option. Planting in a staggered arrangement allows maximum coverage with the least amount of plants. See Figure 1.1.

Another pointer for the success of bedding plants and ground covers is to follow the cultural requirements of the plants. Plant sun-loving plants in the sun and shade-loving plants in the shade. Do not plant shorter plants behind taller ones. The effect of a bed or border could be ruined by this mistake.

Figure 1.1 - Staggered Row Planting Pattern



Removal from containers - Bedding plants and ground covers are purchased in plastic packs, individual plastic pots, clay pots, or peat pots. In order to install the plants they must first be removed from the container with little damage to the root system. Plants in packs can be removed by pushing the bottom up with

Figure 1.2 - Removal of Plants from Plastic Packs

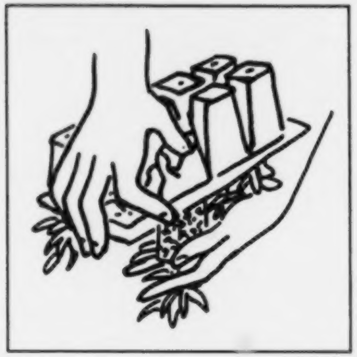


Figure 1.3 - Removal of Plants from Individual Pots

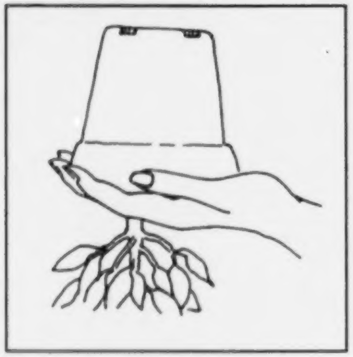


Figure 1.4 - Plants in Peat Pots

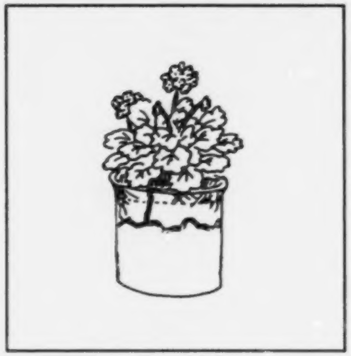
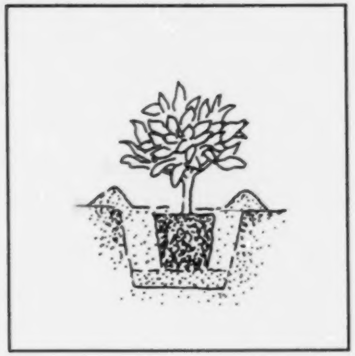


Figure 1.5 - Planting



your thumb and then lifting the rootball out of the pack. See Figure 1.2. Straighten or remove any roots coiled around the bottom.

Individual plastic and clay pots can be tipped upside down while holding the soil by placing your hand over the top of the pot with the stem between your fingers. Tap the edge of the pot on a solid surface. The rootball should fall into your hand. See Figure 1.3.

Peat pots can be planted with the plant. See Figure 1.4. The top rim should be removed down to the soil line. Be sure the pot is buried completely. Any part sticking out will act like a wick drawing moisture away from the rootball.

All plants should be moist before planting. Never plant a dry plant. The plant will come out of the container more easily and will get established more quickly.

Use a trowel to dig a hole slightly larger than the rootball. The plant should be planted no deeper than it was in the container See Figure 1.5. Gently push soil up around the rootball. Tamp the soil with the end of the trowel or your hand to remove air pockets. Water the plants thoroughly.

Mulches

Mulches are used to conserve moisture, keep weeds down, modify temperatures, and cut down on weeding and cultivation. Mulches should be two to four inches thick to be effective. Possible types of mulches are shredded bark; old sawdust; pebbles; sphagnum moss; leaf mold; rotted manure; compost; and rice, almond, or cocoa bean hulls.

Some mulches help improve the soil over time. Some add nutrients or can alter pH. Nitrogen must be added to compensate for that used in the breaking down of the mulch by microorganisms. Some commercial mulches are nitrogen-fortified. A mulch should be weed and seed free. When mulching ground covers, apply the mulch after the ground freezes to keep it frozen. Repeated freezing and thawing heaves plants out of the ground which kills them.

Summary

Following the proper procedures in soil preparation is the first step in a successful, bedding plant design. After determining the types of plants and the spacing they need, transplanting properly is essential. When the bed is planted, mulch will add the finishing touch.

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After bedding plants or ground covers are planted, the hardest work is finished. However, not all work is completed. The plants must be maintained throughout the growing season in order for them to look their best. The maintenance practices are watering, fertilizing, pruning, grooming, and weed control.

Water Requirements

Bedding plants and ground covers need a constant supply of water after being transplanted. The soil should not be soggy, but plants should also not show signs of wilt before watering. Some plants, like portulaca, like to be in dry conditions; while others, such as coleus, like wet conditions. On the average, bedding plants like to have regular watering. This helps keep the plants in bloom.

Once bedding plants and ground covers are established, their water requirements should be less frequent. It is always best to test the soil with one's hand to determine if the plants need water. Fingers should be placed an inch below the soil surface. If the ground is dry, the plants probably need water.

When watering; it is best to water deeply and thoroughly less frequently; than light, frequent watering. Deep watering promotes a larger, deeper root system; thus, the plants need less attention. A shallow root system requires extra irrigation and allows weeds to grow.

Follow the cultural requirements of the plants in order to determine whether they are water-loving plants, or whether they like a dryer environment.

It is best to water in early morning before the sun is high in the sky. Try not to water in late evening when the foliage will stay wet during the night. This can promote favorable conditions for disease organisms. Also, try to keep the foliage dry. Wet foliage can cause diseases and the weight of the water can knock some plants over. A sprinkler system, soaker hose, or a hand held hose with a breaker arm and nozzle, are all ways to water.

Fertilizer Requirements

Bedding plants are not heavy feeders. If the planting soil is prepared well with fertilizer, bedding plants will need possibly only one or two additional feedings. Once a month will suffice. Use a complete fertilizer (one containing nitrogen, phosphorous, and potassium) with either a 1-1-1 or 1-2-1 ratio. A 5-10-5 is commonly used. The fertilizer label should be followed for the amount. This is usually two to three pounds per 100 square feet. Sprinkle the fertilizer on the ground, scratch it in, then water it well. If a mulch is used, sprinkle the fertilizer on the mulch and water in.

A liquid fertilizer can be used for smaller plantings and applied monthly or diluted and used bi-monthly.

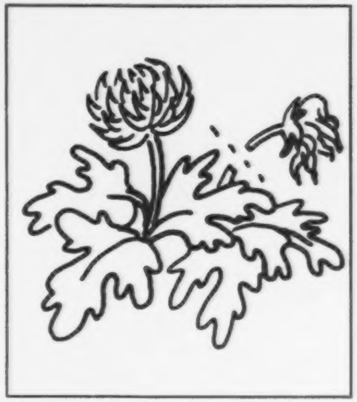
A soil test will determine if ground covers need to be fertilized. A general rule would be to use three pounds of a commercial fertilizer such as 5-10-5 per 100 square feet as an annual spring application. Fertilizer should be applied in early spring before growth starts. Some plants become leggy in fertile soils. Check the cultural requirements of the plant before fertilizing.

Pruning and Grooming

Some ground covers need annual trimming to rejuvenate new growth. There is no set schedule for trimming or pruning. When the ground cover starts to look dull, or when it is building up thatch, is a good time to prune. Early spring before growth starts is the best time. A lawn mower can be used if mowing height is set at about four to six inches. A bag should be used to catch clippings. Enonymus, phlox and ajuga can be pruned this way. It is fast and labor-saving. Some areas where a mower will not work can be trimmed by using a string trimmer (weed-eater). It is important to keep the trimmer at an even height from the ground over the entire area. This method is good for steep slopes.

Some plants benefit more from hand pruning. Use pruning shears or hand shears. Some plants like Ajuga reptans need to have their

Figure 2.1 - "Dead-Heading"



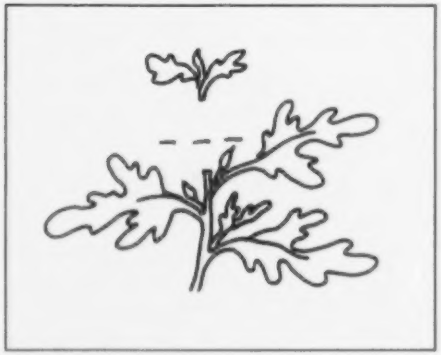
blooms removed. This can be done by a mower and bag.

Bedding plants need to have spent blooms removed, which is called "dead-heading", about once a week. See Figure 2.1. This helps the plants to look better and promotes longer blooming time. After an annual blooms, if it is allowed to go to seed, the blooming process is slowed down. The seeding triggers a message to the plant that its life cycle is coming to an end; therefore, it slows blooming.

Some plants respond well to pinching when transplanted. The terminal bud is removed to promote lateral growth. See Figure 2.2. This promotes a bushier plant with more stems to bear flowers.

Some plants require staking. See Figure 2.3. This keeps the tall plants growing upright, safe from wind and rain damage.

Figure 2.2 - Pinching

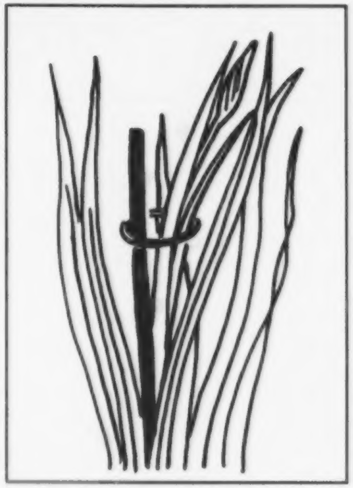


Most ornamental grasses should not be cut back until spring (March). Keeping the leaves intact during the winter helps its cold-hardiness. Check the cultural requirements of each plant for its specific needs.

Summary

It is often thought that once bedding plants and ground covers are planted, the work is over and the maintenance of a flower bed takes care of itself. Landscapers will find many benefits if they take time to follow through with maintenance practices of watering, fertilizing, pruning, and grooming.

Figure 2.3 - Staking



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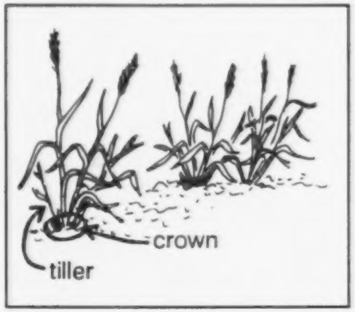
The oldest and most common plant used in landscaping is turfgrass. One reason for this is that turfgrass gives an attractive appearance if it is well-kept.

About 1500 different kinds of grasses grow in the United States. Some of the many species in the grass family are corn, bamboo, sugar cane, range grass, pasture grass, and turfgrass. Of these 1500, approximately 225 grow in Missouri. Only 40 types of grasses are cultivated especially for turfgrass; each with its own adaptations. In Missouri there are six major turfgrasses that homeowners and managers of recreational areas use.

Figure 1.1 - Bunching Growth Habit



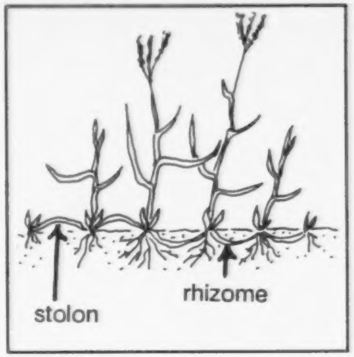
Growth Habits

Grasses have two basic growth habits, bunching and spreading. Bunching grasses reproduce only tillers as illustrated in Figure 1.1. Several new tillers are produced at the plant crown, but since there is no horizontal growth the plants remain attached as a bunch or clump of grass. Spreading grasses, as illustrated in Figure 1.2, reproduce either by rhizomes and/or stolons. Rhizomes are stems that grow horizontally just below the soil surface; whereas, stolons are stems that grow horizontally just above the soil. Both rhizomes and stolons have the ability to creep six inches to three feet in a single growing season. Rhizomes and stolons also produce new shoots as they travel along or under the ground.

Cool-Season vs. Warm-Season

Turfgrass, as well as other plants, grows best under ideal conditions. Some turfgrasses are adapted for hot, dry weather while others require cooler temperatures for optimum growth.

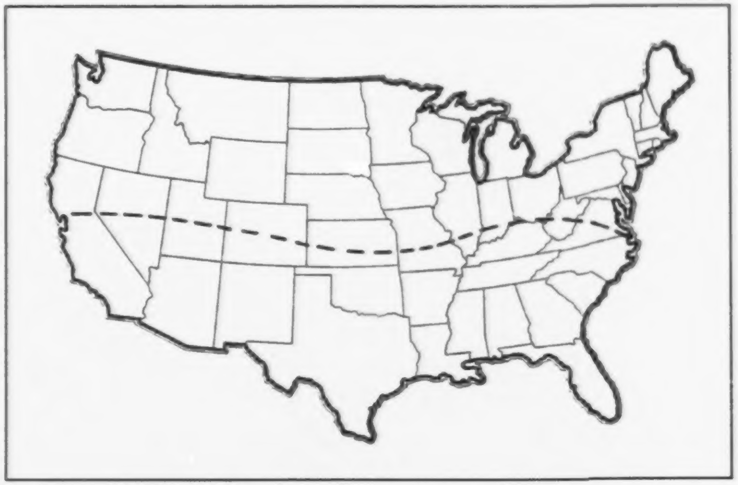
Figure 1.2 - Spreading Growth Habit



Turfgrasses are divided into two major groups: warm-season and cool-season. The United States is divided into two major regions. See Figure 1.3. The border where these two regions meet is called the transition zone. Both warm-season and cool-season grasses can grow in this transition zone, where temperatures do not reach extremes. Missouri is located in the transition zone. The six major turfgrasses grown in Missouri are either warm-season or cool-season turfgrasses.

Cool-season turfgrasses grow best with daytime temperatures between 60-75°F. They are the first to green in early spring. During hot, dry summers, cool-season turfgrasses will slow their growth, wilt, and

Figure 1.3 - Regions of Grass Adaptations



eventually become brown and dormant. Some plants may die during extended periods of summer drought.High temperatures may result in thinned lawns. As cooler temperatures arrive with autumn, lawns that have survived the summer will initiate new growth in the form of tillers and secondary shoots. This spurt of growth in the fall is vital in order that lawns may recover and regain their density before winter arrives.

Warm-season turfgrasses grow best with daytime temperatures between 80-95°F. They begin to green four to six weeks after cool-season turfgrasses. During extended drought, warm-season grasses may turn brown and dormant but will have a much greater chance of surviving the summer drought than cool-season grasses. After the first frost of autumn, warm-season turfgrasses will turn straw-colored and become dormant until warmer temperatures of late spring. See Figure 1.4.

In general, warm-season turfgrasses are more aggressive; growing more vigorously in warmer weather; than cool-season grasses.

Advantages and Disadvantages of Turfgrasses

The adaptability of a grass will determine how and where it will be used to provide a functional turf. Of the six major turfgrasses grown in Missouri, four are cool-season and two are warm-season. Table 1.1 lists the turfgrasses. Each of these turfgrasses has advantages and disadvantages.

Figure 1.4 - Warm vs. Cool Turfgrass Growth Rates and Temperatures

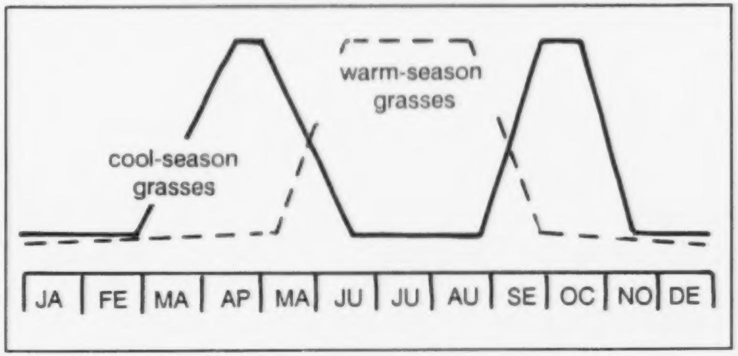


Table 1.1 - Missouri Turfgrasses

Warm-Season Turfgrasses	Cool-Season Turfgrasses
Bermudagrass	Kentucky bluegrass
Zoysiagrass	Perennial ryegrass
	Tall fescue
	Fine fescue

Kentucky bluegrass - This is a cool-season, sod-forming grass that produces rhizomes. This turfgrass grows best in sunny areas. If grown in favorable soil conditions, Kentucky bluegrass can be very aggressive. It can even survive severe winters. Spreading rhizomes will help the turf recover from wear or injury. In addition, Kentucky bluegrass will establish a lawn from seed. As is typical of most cool-season grasses, Kentucky bluegrass will become dormant during hot, dry summers. Therefore, it should receive supplemental irrigation to keep it growing actively during the entire summer. Kentucky bluegrass is moderately susceptible to insects and diseases. Most of the cool-season turf sold as sod in Missouri is Kentucky bluegrass. Some Kentucky bluegrass cultivars include the following.

1. Low maintenance area types; Aquila, Kenblue, Park, Arboretum, Common, Delta, Delft, Geary, Palouse, Piedmont, South Dakota, Cougar, Newport, and Prato.
2. Medium to high maintenance area types; Bristol, Princeton, Eclipse, Challenger, America, Rugby, Sydsport, Classic, and Synthia.
3. Types with improved resistance to diseases; Aspen, Adelphia, Columbia, Parade, and Bristol.

Tall fescue - This cool-season, bunch grass has recently been improved and is now widely accepted as an attractive, drought-tolerant, lawn grass. Tall fescue grows best in full sun, but also performs well in moderate shade. Tall fescue has a deep, root system that helps it survive summer drought. It also has fewer disease and insect problems than other cool-season grasses. It has good resistance to traffic, but will tend to result in a clumpy turf when excessive wear causes a thinning of turf cover. In high-traffic situations, such as athletic fields, tall fescue should be seeded with a mixture of Kentucky bluegrass. In Missouri, tall fescue can be established from seed or purchased as sod. Some tall fescue cultivars include the following.

1. Forage-types; Fawn, Alta, Kenhy, Goar, and K-31 (use only K-31 for lawns).
2. Turf-types with good quality; Arid, Jaguar, Apache, Bonanza, Rebel II, Mustang, Adventure, Olympic, Finelawn, Hounddog, 5GL, and Trident.

Fine fescue - This is a general category of cool-season grasses that includes hard fescue, creeping red fescue, and chewing fescue. Fine fescues are particularly noted for their very narrow leaf blade and excellent shade tolerance. Creeping red fescue produces rhizomes, while hard and chewing fescue are bunch grasses. Fine fescues have a low fertility requirement and can withstand moderate soil, and drying in shady conditions. They are sensitive to some pesticides and not very resistant to diseases and insects. Fine fescues have poor, wear-tolerance. Red fescue and hard fescue are generally mixed with Kentucky bluegrass and perennial ryegrass when used in full sun areas. Of all the fine fescues; hard fescue is preferred in Missouri because of its superior heat, drought, and disease resistance. Some fine fescue cultivars include these improved disease-resistance types; Aurora, Reliant, Scaldis, Flyer, Dawson, Banner, Highlight, Jamestown, Koket, and Shadow.

Perennial ryegrass - This cool-season, bunch grass performs extremely well during spring and fall in Missouri; but has some difficulty tolerating the heat, drought, and disease pressure associated with summer. Perennial ryegrass germinates rapidly, is a very competitive seedling turf, and is extremely traffic-tolerant once established. These attributes have made it a favorite choice for repairing heavy use areas, such as athletic fields. Perennial ryegrass has a moderate degree of resistance to disease and insects. Dormant, warm-season grasses can be over-seeded with perennial ryegrass to provide green color and a more functional turf during the cooler periods of the year. Some perennial ryegrass cultivars include these improved summer-performance types; Allaire, Birdie II, Gator, Manhatton II, Patriot, Ranger, Repeli, Rodeo, SR-4000, SR-4100, and Tara.

Bermudagrass - This is a warm-season, spreading grass that produces both rhizomes and stolons. It has a deep, root system and grows well from mid-May through mid-September. Bermudagrass grows exceptionally well in full sun and will not tolerate even slight shade. It is extremely aggressive and recovers well when damaged. Two major disadvantages of Bermudagrass are its susceptibility to winter kill and over aggressiveness causing contamination of flower beds and gardens. Improved cultivars of Bermudagrass are propagated vegetatively by either sprigging, sodding, or plugging. Some Bermudagrass cultivars include these types developed for transition zone; Midiron and Vamont have improved winter tolerance, while Tufcoate and Tifway are used only in southern Missouri.

Zoysia grass - This is also a warm-season, sod-forming, grass that produces both rhizomes and stolons. It is more winter-tolerant than Bermudagrass but is less aggressive. Zoysia has better shade tolerance than Bermudagrass as well. Zoysia is slow to establish itself and will grow in most soil types. When properly cared for, zoysia provides a very dense lawn that requires less nitrogen, mowing, weed control, and irrigation than most other turfgrasses used in Missouri. Zoysia tends to build thatch, especially when higher nitrogen rates are used to promote a deeper green color. Meyer is the only zoysia cultivar used in Missouri.

Table 1.2 compares the different turfgrasses grown in Missouri.

Table 1.2 - Lawn Grass Comparison

	Bermudagrass	Zoysia grass	Perennial ryegrass	Tall fescue	Fine fescue	Kentucky Bluegrass
High Temperature Tolerance	2	1	5	3	6	4
Drought Tolerance	1	2	6	3	5	4
Cold Tolerance	6	5	4	3	2	1
Shade Tolerance	6	5	3	2	1	4
Establishment Time	1	6	2	3	4	5
Wear Tolerance	2	1	4	3	6	5

*1 = most desirable 6 = least desirable

Summary

Although there are many kinds of turfgrasses, only six major types are grown in Missouri. These include Kentucky bluegrass, tall and fine fescue, perennial ryegrass, Bermudagrass, and zoysia grass.

Turfgrasses are grouped according to their growth habits. Grasses form as bunch type or sod-forming type, depending on whether they produce rhizomes, stolons, or tillers. Turfgrasses are also categorized as warm-season or cool-season depending on the optimum season for growth. All turfgrasses have distinguishing characteristics. All three factors; propagation, temperature preference, advantages and disadvantages; should be considered when establishing, maintaining, or renovating a lawn or recreational turf area.

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Turfgrass is established by following the steps in a particular process, in order to introduce turfgrass to a new area. Turfgrass establishment brings beauty to any landscape. When preparing an area for turf, it is extremely important not to hurry the process. A mistake made at this time will be evident later, and will result in extra time and labor. A beautiful, successful turf is dependent upon many factors, including initial soil preparation.

Preparation of the Site for Installation

There are a number of steps to follow when preparing a site for turf installation. All steps may not be required, depending upon the site itself. These steps include a soil test; soil preparation, including establishment of a rough grade; addition of lime, fertilizers, and soil amendments; and final grade.

Soil test - A soil test is an important step in the turf establishment process. It determines the lime and fertilizer needed to ensure successful turfgrass establishment and future growth. The soil test will also indicate the pH of the soil. A soil test and sample bags may be obtained from your area extension office. Soil tests should be taken two months prior to the planting date to allow enough time to receive the test results.

Soil Preparation - Preparation of the soil is the next step. Proper attention to grading will result in good surface drainage. This is accomplished by pushing aside the topsoil during the rough grading and replacing it later during the final grading. Remove all debris; such as large stones, tree roots, and discarded construction materials. This debris could interfere with turfgrass root growth and water movement through the soil. Till the subsoil.

Adding lime, fertilizers and soil amendments - Next, apply necessary lime, fertilizers, and soil amendments. A soil test will indicate the amendments or organic matter required. Fresh organic matter such as; manure, straw, or fresh sawdust; is not usually recommended because it will cause a temporary nitrogen imbalance. Peat moss or compost are recommended. Organic matter should be worked into the top two to four inches of soil before adding the starter fertilizer.

Apply the recommended lime, phosphorus, and potassium according to the soil sample test results. Thoroughly till the lime and fertilizer materials into the four to six inches of the soil surface. A starter fertilizer can also be used immediately prior to seeding. Starter fertilizer should have a 1:2:1 ratio.

Final Grade - After the addition of lime, fertilizers, and amendments; the next step is the final grade. A proper final grade will be firm enough to prevent ruts created by equipment. The soil surface should be loose and crumbly so that seed can be easily raked into the surface at least one-fourth inch in depth. Once these steps have been properly followed; the site is ready to be installed with the turf by seeding, sodding, plugging, or sprigging.

Installation of Turf

There are four different ways to install turfgrass: seeding, sodding, plugging, and sprigging. Seeding has the advantage of offering many more species and varieties to choose from. Seeding is also less expensive than other methods of turf installation. However, the large amount of time required for seed to germinate and become well-rooted is a disadvantage. Seeding of cool-season grasses should be done in early fall or early spring, because of the cooler temperatures.

Seeding - In small areas, seed can be sown by hand. For larger areas, a fertilizer spreader can be used. Spreaders should be calibrated to supply half the amount of seed in one pass over the area. Spread the first group of seeds. Then spread the second group of seeds over the first at a right angle to the first group. When seeding by hand try to apply 10 seeds per square inch. Rake the seed, to cover with one-eighth to one-fourth inch of soil, and roll with a roller. A light layer of straw is used as a mulch. This will help germination, keep the soil moist, and protect the young seedlings. The soil needs to remain moist from the surface to just below the root zone. Use a fine spray to sprinkle seeds three to four times per day until young seedlings are established. As grass develops, irrigation should be deeper and less frequent.

In order to purchase seed for a lawn, the landscaper must select the turfgrass, know the seeding rate for the turfgrass selected, and figure the area of the lawn to be seeded. Once the type of turfgrass is selected, the area to be seeded needs be determined. It is usually easier to work with square feet when calculating the seeding area. See Table 2.1 for suggested seeding rates, which are usually expressed as pounds per 1000 square feet. The area times the rate of application will give the number of pounds of seed required to seed the lawn. See the example below.

$$\overset{\text{(A)rea}}{6{,}000 \text{ sq. ft.}} \times \overset{\text{(R)ate}}{\frac{3 \text{ lbs. of seed}}{1{,}000 \text{ sq. ft.}}} = 18 \text{ lbs. of seed}$$

The cost of the seed can be determined by multiplying the number of pounds of seed times the cost per pound of seed.

Sodding - Sodding is the installation of commercially-grown turf that is pre-cut into strips with attached roots, rhizomes, or stolons. Choose only high quality sod that is actively growing. Sod is sold by the square yard in rectangular strips. To lay sod , start with a straight edge such as along a driveway or sidewalk. Unroll sod pieces, pressing them tightly against each other, but making sure not to overlap them. Using a sharp knife, cut pieces to fit curves or small areas. After sod has been laid, roll with a rolling machine to ensure good contact with the soil. Water it thoroughly. Some areas have a tendency to dry out, so be sure to spot water every day.

Sod has the big advantage of providing an immediate turf. It will also help minimize erosion on slopes. A disadvantage of sod is the cost and amount of labor required.

Plugging - Plugs are pre-cut pieces of sod, usually one to two inches in diameter with one to two inches of soil attached. Plugs should fit tightly in prepared holes and be tamped firmly into place. Plugs are placed six to twelve inches apart.

Sprigging - Sprigs are pieces of torn turf usually containing a stolon with roots. Sprigs can be broadcast over an area and covered lightly with soil; or placed in rows six to twelve inches apart. One bushel of sprigs amounts to approximately one square yard of sod.

Irrigation of new seedlings, sod, plugs, and sprigs is extremely important to ensure successful installation.

Time of Planting

The planting time of turf is important. The best time to seed lawns with cool-season grasses is between August 25 and October 15. Lawns seeded within one week of Labor Day are more likely to fill in completely by winter. Seeding in spring can be difficult because daily watering is required. Watering will promote excessive weed growth, and increase the chance of diseases in seedlings. Cool-season grass sod can be installed almost any time of year except during mid-winter or drought conditions.

Warm-season grasses should be planted between early May and mid-July. Fall seeding is not recommended because there is not sufficient time for proper installation before cold weather arrives. Warm-season sod can be laid from late March through July.

Seed Selection

Seed should be bought from a reliable source. It should be healthy, have a high germination percentage, and be weed and disease free. In addition, the kind of seed selected should be adapted for the area. Seed size and growth habit determine the amount of seed needed for an area. Refer to Table 2.1 for recommended seeding rates.

Seed can be sold as mono cultures, mixtures, and blends. Mono cultures contain only one kind of grass seed. They produce a uniform turf but are disease-prone. Mixtures are seeds of two or more kinds

Table 2.1 - Seeding Rates

Grass Species	Pounds per 1000 sq.ft.	Days to germination
Kentucky bluegrass	1.5-2.5	6-30
Perennial ryegrass	6-10	3-7
Tall fescue	6-10	7-12
Bermudagrass	1-2	7-30
Fine fescue	4-6	5-10

(species) of grasses. A weakness in one grass will be compensated for by the strength of another kind of grass in a mixture. Blends are one kind of grass composed of many cultivars.

A label on a seed package provides a lot of information. Percentages of grass seed represent the percentage of seed by weight of contents. Germination percentages are the percentage of seeds that will germinate in proper conditions. There are other materials in the package besides seeds. These other ingredients are listed on the label and include inert matter, weed seeds, noxious weeds, and crop seeds. A good mixture will have a low percentage of weed and crop seed, an absence of noxious weeds, and a high percentage rate of germination. See Figure 2.1 for an example of a seed information label.

Figure 2.1 - Seed Information Label

GRASSES		GERMINATION
40%	Kentucky bluegrass	80%
39%	Tall fescue	85%
20%	Perennial ryegrass	85%

OTHER INGREDIENTS

.02%	Crop seed
1.00%	Inert matter
.10%	Weed seed
0	Noxious weeds

Summary

The establishment of turfgrass enhances any landscape. Turf can be installed by seeding, sodding, plugging, or sprigging. Before the actual installation of turf, the soil must be carefully prepared. Each procedure is different, but thorough and careful watering is the vital last step in each. The timing for turf installation depends on the grass type and the region. When seeding, it is important to choose the seed according to the type of turf desired. Always buy good quality seed, sod, plugs, or sprigs. The label of a seed package contains information that will aid in the purchase of good quality seed.

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Unit VIII - Turfgrass

G06700	Bluegrass and Fescue Lawns: Establishment
G06705	Bluegrass and Fescue Lawns: Maintenance Calendar

The way turfgrass is treated determines whether the desired lawn will be achieved. Just as a person needs to maintain a well-balanced diet to remain healthy, the turf must be maintained with a well-balanced diet. Fertilizing, watering, and mowing are the components of a well-balanced turf diet.

Fertilizing

A complete fertilizer containing nitrogen, phosphorous, and potassium is essential for successful turfgrass growth. Using Nitrogen is the key to good turf growth. It stimulates vegetative growth and rich color in turf. There are two types of nitrogen fertilizers: organic and inorganic. Organic nitrogen is the natural form of nitrogen. It is slowly released into the soil. Inorganic nitrogen is manufactured and available in fast-acting and slow-release formulas. Do not overapply fast-acting nitrogen because it has a tendency to burn the turf. A nitrogen deficiency in the soil can be detected when the turf turns pale in color. Another symptom of nitrogen deficiency is slow growth rate during the growing season.

Phosphorous is another essential macronutrient for turf growth. Phosphorous is necessary for stimulating good root growth. Roots can be checked by pulling out a sample of the grass. If a phosphorous deficiency exists, roots will not look white or healthy. Since roots are the main source of water and nutrient absorption, a phosphorous-deficient turf may appear weak.

Potassium is necessary for good plant growth as well. Potassium strengthens and protects turf against diseases and the wear of foot traffic.

By state law, every bag of fertilizer must have a printed label indicating fertilizer ratio. A ratio of 3-1-2 is advised for turfgrass. The fertilizer bag should also list the method of application and any other important information. See Figure 3.1. The amount of fertilizer to apply to turfgrass depends upon temperature, length of the growing season, amount of foot traffic, and amount of maintenance desired.

Figure 3.1 - A Sample Fertilizer Label

USA reg. 000-0000

LAWN FERTILIZER 25-4-7

GUARANTEED ANALYSIS

TOTAL NITROGEN (N) 15%

3% WATER-INSOLUBLE - SLOW RELEASE N
4% AMMONIACAL NITROGEN - FAST RELEASE N
8% UREA NITROGEN - FAST RELEASE N

AVAILABLE PHOSPHERIC ACID (P_2O_5) 6%

SOLUBLE POTASH (K_2O) 6%

Primary Plant Nutrient Sources: Urea form, Urea, Ammonium Phosphate, Potassium Nitrate

Potential Acidity 750 lbs. Calcium Carbonate Equivalent Per Ton

Manufactured by: Fertilizer Products Co., Anytown, USA

Warm-season grasses prefer fertilizers applied twice a year; once in early summer, and again in midsummer. Cool-season grasses should be fertilized twice a year; September and November, and additional fertilization can be applied in spring. No more than one pound of fast release nitrogen should be applied per 1,000 square feet at a time.

One option in lawn fertilization is to use a "weed and feed" fertilizer. This is a type of fertilizer that fertilizes the turf while it helps control weeds.

In order to determine how much fertilizer will need to be purchased, the area to be fertilized needs to be determined first. Proportions are used to determine how much of a product is needed to be applied at a specific rate on an area.

(A)-Area needs to be determined first. It is usually easier to work with square feet.

(R)-Rate of application should be a given rate. This is usually pounds per 1,000 square feet.

(N)-Nutrient analysis will give the percentage of the specific ingredient to work with. This is represented as pounds of active ingredient per 100 pounds of fertilizer.

Example:

$$\underset{\text{(A)rea}}{4{,}000\ \text{sq. ft.}} \times \underset{\text{(R)ate}}{\frac{1\ \text{lb. Nitrogen}}{1{,}000\ \text{sq. ft.}}} \times \underset{\text{(N)utrient analysis}}{\frac{100\ \text{lbs. fert.}}{15\ \text{lbs. of N}}} = 27\ \text{lbs. of fert.}$$

Cost: 27 lbs. of fertilizer x cost per pound = cost

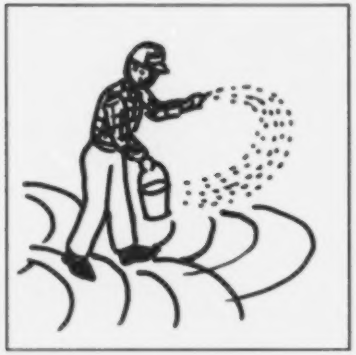


Figure 3.2 - Broadcasting by Hand

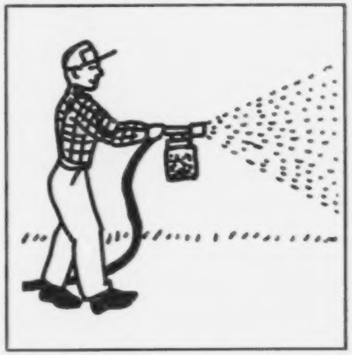
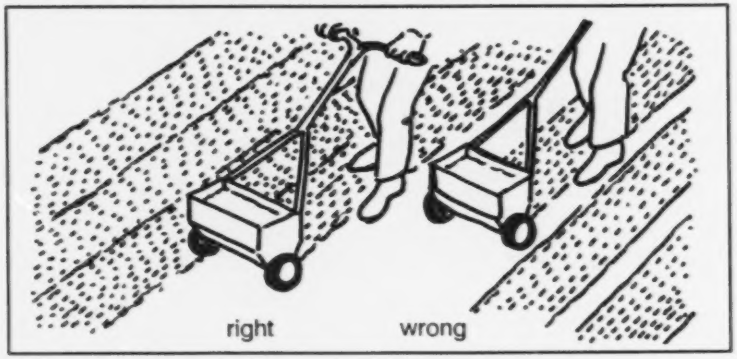


Figure 3.3 - Applying Liquid-Feed Fertilizer

Figure 3.4 - Applying Fertilizer with a Drop-type Spreader



Fertilizer can be applied by hand broadcasting, liquid feeding, or by a fertilizer spreader. Broadcasting by hand is recommended for use of solid, organic fertilizers in small areas. See Figure 3.2. When broadcasting, split the amount of fertilizer to be used into two equal amounts. Broadcast one amount over the total area and then broadcast the other amount on top of the first at right angles, forming a grid pattern. A hose end proportioner or pressurized tank is needed for the spray, liquid-feed fertilizer. See Figure 3.3.

There are two types of fertilizer spreaders: broadcaster and drop-type. Mistakes can be easily made when applying fertilizer with a spreader, so care must be taken. One method, which uses a drop-type spreader, is to apply two rows of fertilizer at each end of the area; then fill in the rest of the area. Place the hopper wheel just inside the previous row to allow even coverage. See Figure 3.4. Avoid making hairpin turns. At the end of a row, turn off the spreader, reposition it for the next row, and turn it on while starting to push it. When using a broadcast spreader, spread half of the fertilizer across the entire yard; then apply the second half perpendicular to the direction of the first half. Do not assume that the dissolved fertilizer will spread evenly over the area. See Figure 3.5. If an area or strip of turf is missed while fertilizing, this

Figure 3.5 - Applying Fertilizer with a Broadcast Spreader

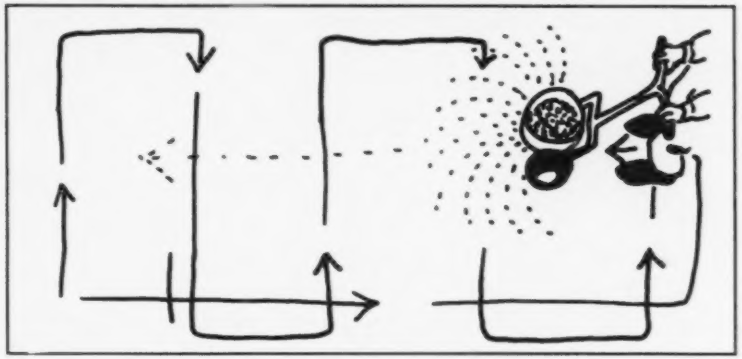
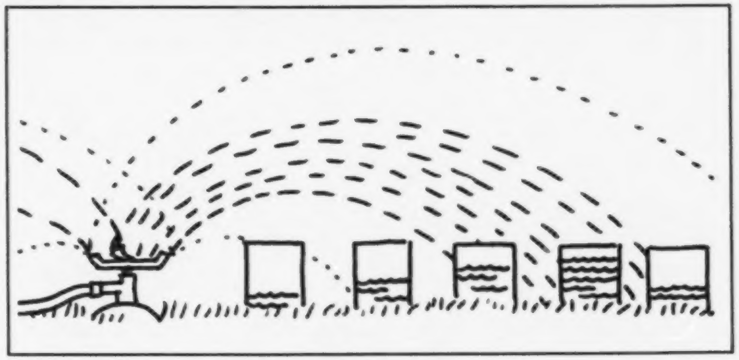


Figure 3.6 - Container Test for Sprinkler



turf will have a lighter green color than the rest of the turf. Be sure to close the spreader when walking over areas that have already been fertilized, since over-fertilization can burn the turf, turning it brown or yellow.

Watering

Besides fertilizing, watering is also necessary to promote actively-growing turf. For the best growth, it is a good practice to water the area thoroughly after fertilizing to allow the fertilizer to penetrate deeply into the soil. How often to water a turf depends upon the soil type, grass type, temperature, growing season, and root growth.

Infrequent, light watering promotes root growth only near the soil surface. Damage occurs during hot spells, when the turf may not be watered for a few days, burning the roots. During peak growth, hot weather, or high winds, it is important to water more frequently. During dormant periods or cooler temperatures, water the turf less often. If the turf is allowed to brown between infrequent waterings, it will take some time for the turf to return to health.

There are several ways to determine when turf needs water. If the grass appears wilted or if footprints remain on the turf, it needs to be watered. A good way to determine soil dryness is to use a soil probe, screw driver, or shovel and dig downward six inches. If the soil probe or shovel enters the soil easily, chances are that the soil is sufficiently moist. If the soil is hard, dry, and crumbly; watering will be necessary.

The primary aim of watering is to wet the entire root zone. Generally, an inch of water will wet the soil to a depth of six inches. It is important to apply the water uniformly and no faster than the soil can absorb it. If a period of seven to ten days pass with less than an inch of rain, supplement by watering.

The container test is an easy method used to determine the amount of water a sprinkler applies to the turf. Place straight-sided containers (old coffee cans will work), in the path of the water. Turn on the sprinkler for one-half hour then measure the amount of water that was collected during that time with a ruler. See Figure 3.6 This will give an idea of how long to leave the sprinkler on in order to get the amount of water needed.

The ideal time to water is in the morning, when there is less wind, temperatures are milder, and there is sufficient time for the roots to absorb the water. In the afternoon, higher temperatures cause water to evaporate. Windy conditions result in poor coverage, blowing water unevenly. Midday watering extends the length of time that leaves are wet and will increase the chance of water-loving diseases infesting the turf. Evening watering is not advised because leaf blades do not have ample time to dry before sunset. At night, wet leaf blades invite disease. Although evening watering is not recommended, it is better than not watering at all. The best recommendation for watering is to water only when the turf visibly needs it.

Mowing

Frequency of mowing depends on the growing season of the turf, grass type, fertilizer maintenance, and watering. Mowing at the recommended heights and times can help prevent weeds, disease, and insects.

It is advised to mow no more than one-third of the leaf blade. If the turf is long, do not automatically mow it down to the proper height. Most of the leaf surface which absorbs sunlight and produces food would be cut off, causing undue stress to the turf. Also, heavy mowing will expose normally shaded areas of turf to the sun, and cause these areas to burn.

Table 3.1 - Recommended Mowing Heights of Missouri Turfgrasses

Turfgrasses	Mowing Height
Zoysia grass	1-2"
Bermudagrass	1/2-1"
Kentucky bluegrass	2-3"
Red fescue	2-3"
Tall fescue	2-3"
Perennial ryegrass	2-3"

Cool-season and warm-season grasses are mowed when they reach certain heights. These heights vary among the different types of grasses. (Table 3.1) Cool-season grasses grow rapidly in the spring and fall and should be mowed at least once a week. During dormant, summer growth, cool-season grasses may require less mowing. Raising the mowing height one inch will help cool-season grasses survive stressful, summer conditions.

Warm-season grasses are mowed more frequently in midsummer, when they are growing at a rapid rate. Mow warm-season grasses less frequently in the spring and fall. Warm-season grasses are mowed to a low height because of their aggressive horizontal growth habit.

The actual mowing height can be determined by measuring from the soil surface to the top of the blade with a stick. Adjust the mower wheels to cut the grass at the proper height.

Some general mowing tips follow.

1. Always pick up sticks, rocks, and other debris in area to be mowed to prevent personal injury or damage to the mower.
2. Cutting wet grass is not recommended because it can spread certain diseases and clog mowers.
3. Sharp turns can result in uneven mowing.
4. Mowing patterns should be alternated to resist soil compaction.

There are two types of mowers: the reel mower and the rotary mower. See Figure 3.7. The reel mower cuts in a scissors-like action; typically using five blades; leaving a smooth, even cut. The reel mower will only cut when propelled in a forward motion. It has no grass catcher. Reel mowers can be either hand or power operated. The blades of a reel mower should be professionally sharpened.

The rotary mower has one blade with a knife-like edge on the outer edge of a rotating blade. This type of mower can cut moving forward or backward. It may have a grass catcher as well. It can cut high grass, weeds, and leaves. The rotary mower can withstand rougher treatment than the reel mower. The blades on a rotary mower can be sharpened by a professional or the owner.

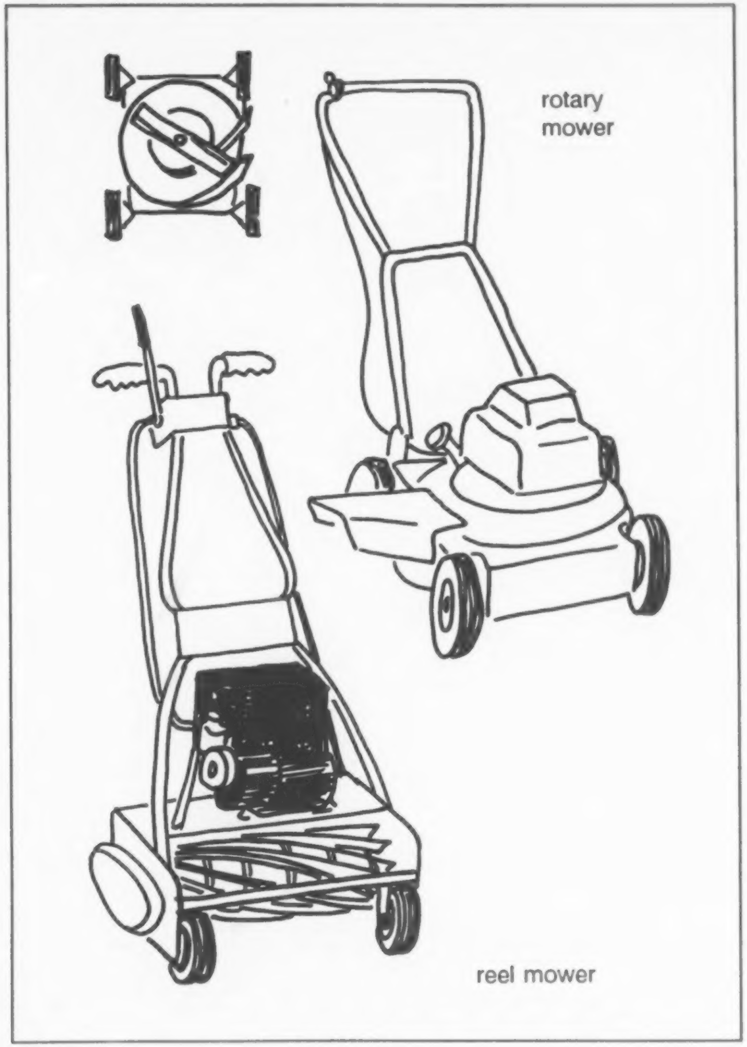


Figure 3.7 - Types of Mowers

Summary

Turf maintenance is important in achieving an attractive lawn and enhancing a beautiful landscape. Fertilizing, watering, and mowing are the most important turf maintenance tasks required for successful turf management. Fertility rates vary for warm- and cool-season grasses. A 3-1-2 fertilizer ratio is recommended. Mowing heights are dependent on kind of grass being cut. Usually one-third of the leaf blade is removed. Turf requires an inch of water every seven to ten days.

Credits

Lawns and Ground Covers. Menlo Park, CA: Sunset Books (Lane Publishing Co.), 1984.

MacCaskey, Michael. All About Lawns. San Francisco, CA: Otho Books (Chevron Chemical Co.), 1985.

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University Extension: University of Missouri-Columbia.

G06700: Bluegrass and Fescue Lawns: Establishment
G06705: Bluegrass and Fescue Lawns: Maintenance Calendar
G06950: Steps in Fertilizing Garden Soil (Vegetables and Annual Flowers)

Proper watering, mowing, and fertilizing will help ensure healthy turf. If the turf begins to deteriorate, and proper maintenance does not help to renew it; cultivation and renovation may be necessary to restore the turf.

Lawn Failure

Improper care will cause problems with turf. Such problems as diseases, insects, drought, thatch, soil compaction, and weeds can be remedied by either cultivation or renovation. Cultivation is the removal of thatch by mechanical means, without harming the turf. Renovation is turf improvement by replanting in thin, weak areas; it may include cultivation, but not always.

Thatch

Thatch can be a problem in many turf areas, particularly those with vigorously creeping grasses. Thatch is a layer of decomposing grass, stems, crowns, and roots found between the grass blades and the soil. See Figure 4.1. The accumulation of thatch increases when the rate of dying grass is higher than the rate of decomposition of the dead grass pieces. There are several causes of thatch:

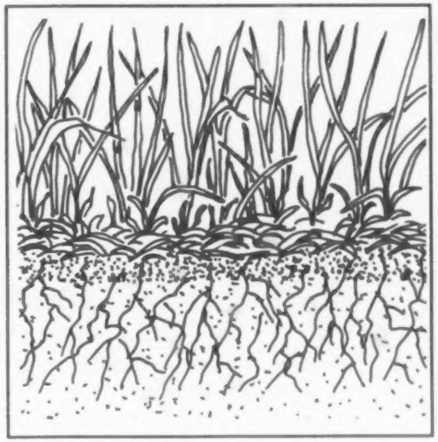
1. Excessive turf growth
2. Overgrown turf, followed by severe, close mowing
3. Fungus disease
4. Prolonged drought followed by active growth
5. Unfavorable conditions for microorganisms and earthworms that aid in decomposition

Thatch Damage

Numerous types of damage may occur if thatch is not controlled. Some of these are as follows.

1. Thatch becomes a breeding place for disease-causing fungi and insects.
2. Prolonged high humidity at grass level encourages disease growth.
3. Shallow roots form.
4. It causes retarded air and water movement through the soil.

Figure 4.1 - Thatch



The heavier and thicker the thatch, the less water, pesticide, and fertilizer can penetrate the thatch layer and soak into the soil. In addition, grass roots have a tendency to grow only in the thatch later, causing a shallow root system that can be especially harmful during hot summers or times of drought. Thatch can also destroy the turf if the problem continues to exist with little or no control.

There are various ways to control thatch. Some of these are as follows.

1. Fertilize moderately and regularly (but not excessively) to maintain good growth.
2. Mow regularly at recommended heights to maintain vigor and to avoid shock to the turf from close mowing.
3. Deep irrigate every ten to fourteen days during drought to promote deep root growth.
4. Rake annually before new growth starts.
5. Practice coring; the removal of small, circular pieces of turf and soil; to improve water and fertilizer penetration.
6. Top dress every two to four years with one-fourth inch of soil to encourage thatch decay.

To determine how thick the thatch layer is, cut out a few sections of turf for observation. When the thatch layer has accumulated to one-half inch, the thatch should be removed. The best time to remove thatch by vertical mowing is when the grass is actively growing and can easily recover. When needed, warm-season grass should be verticut in mid summer; cool-season grasses are dethatched in autumn.

Small areas of thatch can be removed manually with a hand rake; however, dethatching equipment is recommended for large areas. A dethatching machine uses revolving vertical knives which cut through thatch, bringing it to the surface to be raked away. See Figure 4.2. It is important to remember to adjust the knives on the vertical mower so that they can penetrate the entire thatch layer and the top inch of the soil. Figure 4.3 shows aerified turf. Figure 4.4 shows core removers. Vertical mowing is not recommended more than once every three years because of the long recovery time of the turf.

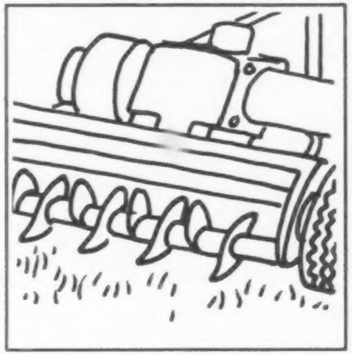
Other methods of dethatching are coring, spiking, and slicing. Coring, or aerification, is the removal of small, circular pieces of turf and soil using hollow tines or spoons. Spiking is the use of solid tines which penetrate the turf and soil surface. Slicing uses rotating, flat, tines that slice through the turf and soil. All three methods; coring, spiking, and slicing; open the turf and soil to allow water and nutrients to flow through the thatch layer into the soil.

Soil Compaction

Soils become compacted when soil particles are pressed together. This reduces the space between the soil particles which prevents water, air, and nutrients from passing through the soil. Clayey soil has more of a problem with compaction than light, sandy soils. Heavy foot traffic contributes to the problem of compaction.

Compacted soils can be mechanically cultivated by loosening the soil or removing small cores. If the soil is too compacted and aerating tools are not able to penetrate the top inch of soil, watering the day before aerating is suggested. Aerating leaves small holes in the turf and soil. These holes will be filled in with growing roots. Top dressing can be applied to compacted soils after aerating. Sand is the preferred top dressing media since it fills the open core hole and aids in rapid drainage.

Figure 4.2 - Vertical Mower



Renovation

Sometimes lawns that have been drastically dethatched; or severely damaged from diseases, insects, or weeds; should be renovated to restore the turf. Renovation means replanting the turf. It may or may not include other cultivation methods, depending upon how severely the turf is damaged. Renovation should be completed in early spring or early fall for cool-season grasses. If a small section of turf is damaged, it is not necessary to remove all the turf. Replace the damaged section with the same type of grass as the rest of the area.

Sometimes a grade change is necessary on established lawns to allow better water runoff. A process of gradually changing the grade over a period of time will be more successful than changing a grade all at once. To gradually change the grade, add or remove a small amount of fill at a time. Add small amounts of top soil or organic matter to help the grass grow.

In some situations it may be desirable to kill all existing vegetation. Dead vegetation should be scalped off by close mowing before using renovation equipment. Verticutters, dethatching machines, can be used on the surface after the grass has been removed. Next, use an aerator to reduce soil compaction and to aid in absorption of water, air, and nutrients. Top soil can be added at this time to change the grade. Rake the area to achieve the final grade. Add lime and nutrients that have been determined to be deficient by a soil test.

Additional verticutting at this time will help to mix the lime and nutrients into the soil surface. Sow grass seed or use sprigs, plugs, or sod to reinstall turf. Water appropriately.

Figure 4.3 - Aerified Turf

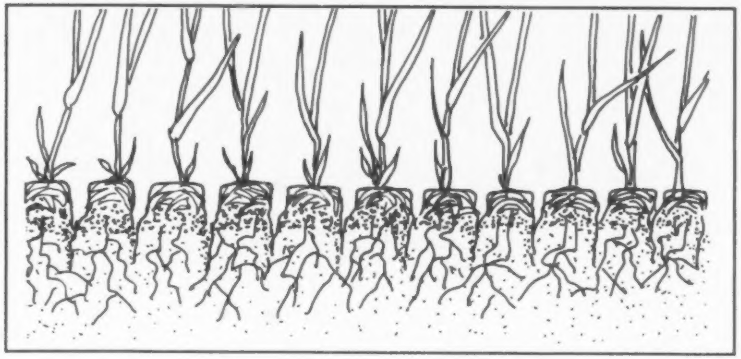
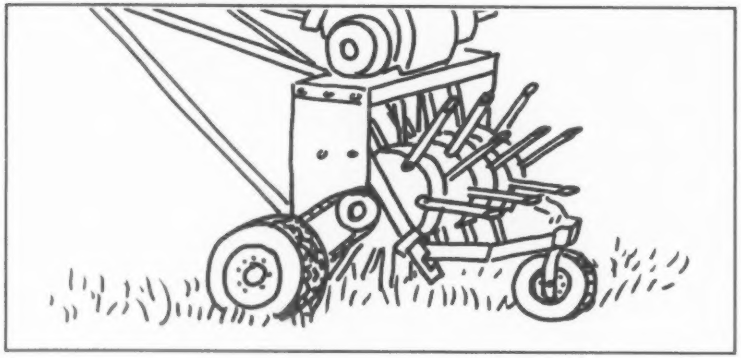


Figure 4.4 - Core Removers



Summary

Proper cultural practices help maintain lush and healthy turf. Lack of proper cultural practices can lead to thatch, soil compaction, weeds, diseases, or insects. These damages can be remedied by cultivation, the removal of thatch; renovation; or a combination of these methods.

Credits

Reily, H. Edward and Carroll L. Shry, Jr. Introductory Horticulture. 3rd ed. Albany: Delmar Publishers, Inc., 1988.

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University Extension: University of Missouri-Columbia.

G06700: Bluegrass and Fescue Lawns: Establishment
G06705: Bluegrass and Fescue Lawns: Maintenance Calendar

Pests

There are three main pests that cause problems for turfgrass: weeds, diseases, and insects. All three pests may occur in a lawn, usually from improper cultural management practices. An actively growing lawn will help prevent pests from establishing themselves and damaging the turf.

Weed Identification

A weed is any plant that is growing in a spot where it is not wanted. Weeds are categorized as grassy or broadleaf. Grassy weeds are monocots and have parallel veins while broadleaf weeds are dicots that have a netted vein pattern.

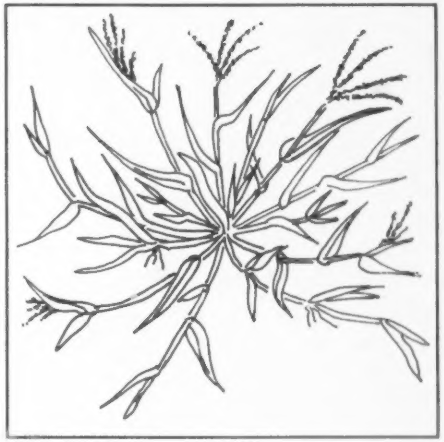


Figure 5.1 - Crabgrass

Crabgrass - Crabgrass, the king of grassy weeds, is a vigorously growing annual, thriving from late May to late autumn. It thrives with close mowing. Control cannot be successful in one growing season because it produces a great number of viable seeds. Crabgrass has pale-green blades, usually two to five inches long and one-third inch wide. Its finger-like flowers rise two to six inches high on narrow stems. See Figure 5.1.

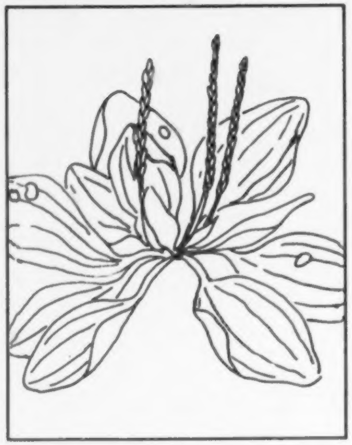


Figure 5.2 - Broadleaf Plantain

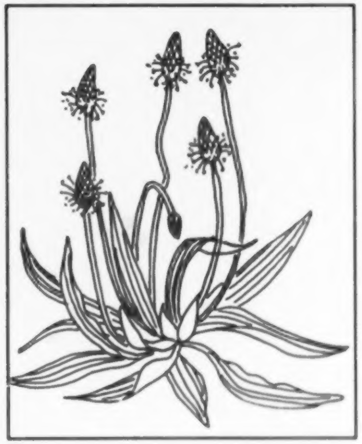


Figure 5.3 - Buckhorn Plantain

Plantains - Plantains are low-growing perennial weeds with basal rosette leaves. There are two types of plantains: broadleaf and buckhorn. Both types germinate in spring and fall. The leaves of the broadleaf plantain are broad, simple, and egg-shaped. The flowers are elongated spikes on the end of an upright, leafless stem. See Figure 5.2. The buckhorn plantain has long, narrow, hairy leaves. Its flowers are tight spikes on leafless, upright stems. See Figure 5.3.

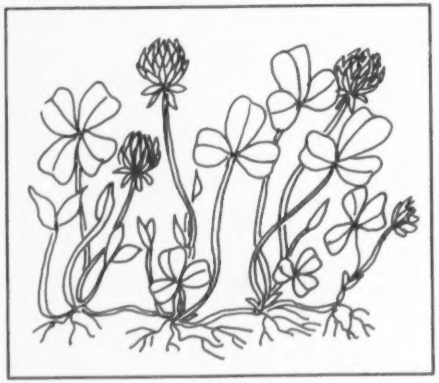


Figure 5.4 - White Clover

White clover - White clover is a perennial weed that has flat-lying stems; compound leaves, with three leaflets, that have white markings; and white flowers that develop on separate, upright stems. Each node that touches soil will develop roots. See Figure 5.4.

Dandelion - Dandelions are low-growing perennials with thick, fleshy

Figure 5.5 - Dandelion

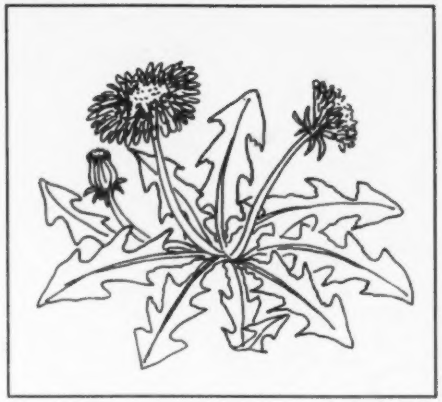
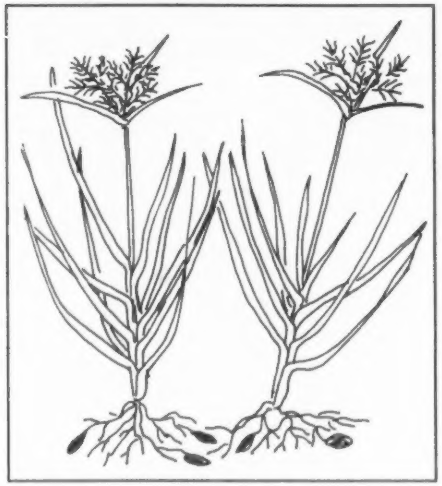


Figure 5.6 - Nutsedge



roots. Deeply-lobed leaves develop as basal rosettes. Yellow flowers grow on single stalks. Dandelions are unusual because the plants can regenerate from pieces of root or stem. See Figure 5.5.

Nutsedge - Nutsedge is a low-growing, grassy, perennial weed. It is light, yellow-green in color and has triangular stems. Yellow flowers develop in panicle arrangements. Small growths, called nutlets, grow on the roots. See Figure 5.6.

Henbit - Henbit is an annual that has opposite, rounded, hairy, coarse leaves. Tiny purple trumpet flowers grow out of square stems. Roots develop easily if nodes come into contact with the soil. See Figure 5.7.

Prostrate Spurge - Prostrate spurge is an annual that forms a mat and thrives with close mowing. Opposite leaves are marked with red blotches in the centers. When the stems are broken, a milky sap oozes out. See Figure 5.8.

Figure 5.7 - Henbit

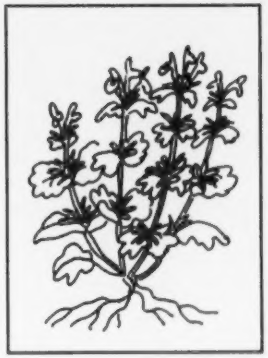
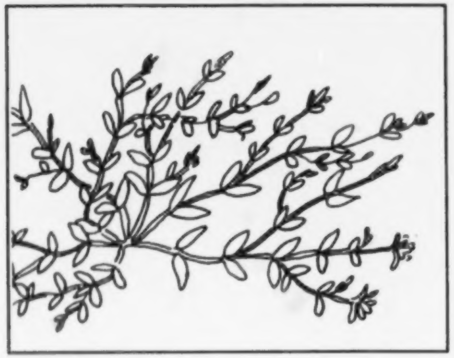


Figure 5.8 - Prostrate Spurge



Curly Dock - Curly dock is a perennial weed with a branched taproot. The leaves are long and have wrinkled margins. They grow to form rosettes. Flowers grow as dense clusters on erect branches. See Figure 5.9.

Common Chickweed - Common chickweed is a winter annual that germinates in fall and grows in spring. Shiny, round, opposite leaves form on hairy stems. Nodes will take root when they contact the soil. Common chickweed has very small, white flowers. See Figure 5.10.

Figure 5.9 - Curly Dock

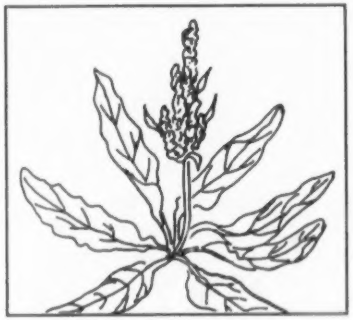


Figure 5.10 - Common Chickweed

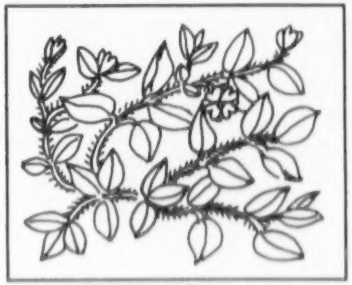
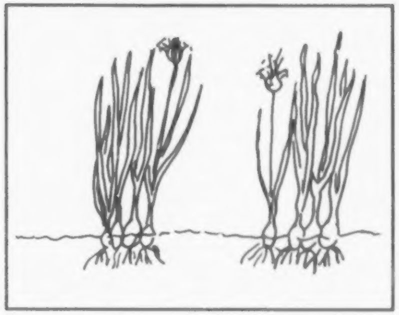


Figure 5.11 - Wild Onion



Wild Onion - Wild onion is a perennial, grassy weed with hollow stems that grow one to three inches tall. It has a characteristic, strong odor; and small, greenish-white flowers that develop on short stems above aerial bulblets. Wild onion reproduces from underground or above-ground bulblets. See Figure 5.11. It is difficult to control because its waxy stems inhibit herbicides from penetrating the plant.

Weed Control

Controlling weeds can be accomplished in two ways; chemical and nonchemical.

Nonchemical control - The best means of nonchemical control is good cultural management practices; which include proper mowing height, appropriate fertilizer rates, and watering. The idea is to produce a dense turf canopy that will compete and suppress weed growth.

Chemical control - Chemical control is a means of killing weeds quickly; it is not a cure. Chemical control should be followed by proper cultural management practices in order to prevent recurrence of weeds. Preemergence herbicides and postemergence herbicides, which can be selective or nonselective herbicides, chemically eliminate weeds. Preemergence herbicides are applied to create a barrier in the soil surface that kills weeds before they germinate. Post-emergence herbicides are applied to actively growing weeds. Selective herbicides control specific weed types; either broadleaf or grassy weeds. Nonselective herbicides kill all plants.

Disease Identification

Diseases can be hard to identify. One of the main reasons, is that environmental conditions or improper cultural management practices, may cause injuries to the turf that can resemble or cause the symptoms of turfgrass diseases. To identify a disease, it helps to know the season of the year in which it occurs. Listed below are the six most common diseases that occur in Missouri, and the months they are likely to appear.

Snow mold - Snow mold is prevalent in late winter or early spring. It is a cold-tolerant fungus that grows in near-freezing temperatures and attacks most cool-season grasses. It first appears in melting snow as tan-colored circles which are a few inches to a few feet in diameter.

Pythium blight - In July and August pythium blight may occur in newly-established turf areas. It is noticed most often in early morning; while the dew is still on the ground; as cottony, circular spots. Pythium blight thrives in warm, wet, humid weather.

Fairy rings - Fairy rings can be any one of fifty fungi which attack turfgrass during the period from April to November. It appears as a ring of mushrooms or puff balls with tall, dark-green grass on the diameter of the rings or arcs. Inside the rings or arcs, the turf is light-colored or dead.

Dollar spot - Dollar spot is prevalent beginning in May and continuing through November. It exists as small straw-colored spots, three inches to one foot in diameter, which can fuse together to cover large areas.

Fusarium blight - Fusarium blight, or summer patch, is a turfgrass disease commonly found from June to August. It appears as light-green patches that turn tan or reddish-brown. Fusarium blight is in the form of rings or arcs of one half inch to eight inches in diameter.

Brown patch - Brown patch is prevalent from July to August. It grows in large, irregular, circular patches that are brown or gray. The edges of the patches appear to be water-soaked. It especially attacks tall fescue.

Disease Control

Diseases of turfgrasses can be controlled chemically or nonchemically.

Nonchemical control - Diseases can be controlled nonchemically by planting grasses with high disease resistance and by using proper cultural management practices. Each separate disease requires its own special cultural control, since each attacks under different cultural conditions. Dethatching, watering, fertilizing, and mowing need to be considered carefully when culturally controlling diseases.

Chemical control - Systemic or nonsystemic fungicides are used for chemical control of turfgrass diseases. Systemic fungicides are most effective, but only control certain fungi. Nonsystemic fungicides are used as preventative measures before the diseases have a chance to start.

Insect Identification and Control

Many insects live in the lawn, but very few damage the turf. In fact, only two insects found in Missouri can totally destroy turf: white grubs and sod webworms.

White grubs - White grubs are the larvae of many different kinds of beetles. A white grub appears as a cream-colored or white C-shaped worm, with three pairs of legs, a brown head, and a dark spot on its posterior end. Damage from white grubs will appear as large brown, irregular patches of turf. A dead area can easily be rolled back as if it were a carpet exposing many damaging grubs. If more than seven white grubs per square foot appear in the lawn, it is time to exert control. Cultural control methods can be combined with chemical controls by dethatching the turf, then using a soil applied insecticide. After applying the insecticide, the soil should be thoroughly watered.

Sod webworms - The sod webworm is only damaging when in the larval stage. Adult sod webworms are actually small moths. Larvae feed at night, chewing off the grass blade just above the thatch line. Sod webworms attack the lawn in late spring or summer, leaving dead patches one to two inches in diameter. Combining dethatching with chemical controls will help kill the sod webworms. Insecticides are effective in controlling sod webworms.

Summary

Healthy, well-managed turfgrass will develop very few pest problems. Problems that do occur are weeds, diseases, and insects. Many kinds of weeds can infest turf; these can be either annual or perennial, grassy or broadleaf. Weeds are usually chemically controlled. A number of turf-damaging diseases can be identified by the seasons in which they appear. Diseases are chemically controlled with systemic or nonsystemic fungicides. Two insects can totally destroy turf, white grubs and sod webworms. They can be controlled by dethatching and using chemical insecticides together.

Credits

Identification and Control of Broadleaf Weeds in Turf. Dow Chemical Co.

MacCaskey, Michael. All About Lawns. Revised Edition. San Francisco: Ortho Books, Chevron Chemical Co., 1985.

Ornamental/Turf Pest Control Manual 89. The Missouri Department of Agriculture and the Cooperative Extension Service, University of Missouri.

Scotts Professional Turf Manual. Marysville, OH: THe O.M. Scott and Sons Co., 1981.

Shurtleff, Malcom C., Fermanian, Thomas W., Randell, Roscoe. Controlling Turfgrass Pests. Prentice-Hall, Inc., 1987.

Sunset Lawns and Ground Covers. Menlo Park, CA: Lane Publishing Co., 1984.

University Extension: University of Missouri-Columbia.

G06750: Lawn and Turf Weed Control
G06951: Understanding and Using Garden and Home Grounds Herbicides
G06952: Garden and Home Grounds Weed Control

Homeowners landscape their homes for many reasons. Landscaping increases the property value of the home. Monetarily, landscaping increases the value of the home by about 10-15%. Landscaping also increases the usefulness, convenience, comfort, and safety of the home surroundings. If a home is landscaped by a skilled designer, a beautiful, well-organized design will be the result.

Landscape design is a problem-solving process. The solutions to landscaping problem areas can be accomplished through three steps: design, installation, and maintenance.

Landscape Design

Landscape design is a combination of art and science that produces a functional and pleasant environment for the client. A sequence of landscape procedures ties all elements and principles of design together. A landscape designer is able to plan and execute one area of a landscape, then shift attention to another area, while still looking at the design as a whole.

Purpose of Landscape Design

The landscape design is a set of ideas put onto paper. It is a written form of communication between the designer and the client. Once ideas are written and drawn, they may be evaluated and changed according to the client's desires. Landscape designs are important because they show the interrelationship of one area of a design to another. Furthermore, an idea has less chance of being forgotten if it is written or drawn.

Site, On-side, Off-site

There are three areas of concern when analyzing a potential tract to be landscaped: site, on-site, and off-site. The site is the area to be designed, installed, and maintained. On-site refers to buildings, features, and vegetation that are already on the land within the client's boundaries. An example of an on-site building or feature might include a shed, garage, swing set, tennis court, or swimming pool. Off-site refers to any building, feature, or vegetation within sight or sound of the landscape site; these could include a highway, nearby trees, woods, trash dumpsters, or a commercial business.

Factors for Preparing A Landscape Design

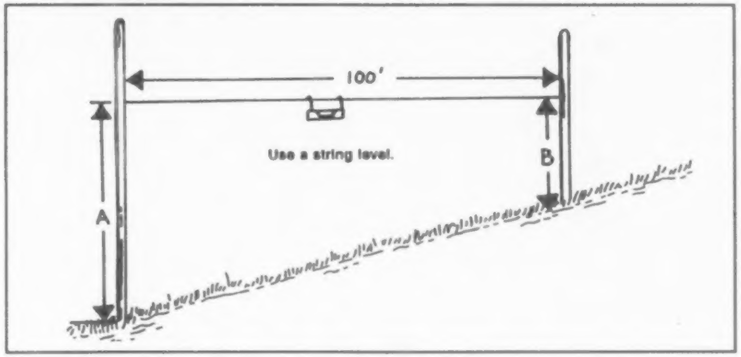
The first steps in the sequence of designing a landscape are site analysis and determination of family needs. During a site analysis, the terrain must be studied for slope and elevation as well as on-site and off-site features. To obtain a thorough analysis of the site, walk off-site to evaluate it. Go into buildings on-site to look out of the doors and windows, taking pictures of the various views.

Site Analysis - Factors to consider and include on a site analysis checklist would be:

1. The terrain
2. Vegetation, house, other buildings, and objects on-site
3. Regional factors such as climate, urban or rural area, nearness to industry, topography, and soil type
4. Zoning regulations
5. Location of utilities (water, electricity, and gas)
6. Vegetation, buildings, and features off-site
7. Direction of the prevailing summer and winter winds
8. Location of North in relation to site
9. Views, drainage

When looking at the terrain, the slope should be determined. Slope is the measurement of the horizontal length in relation to the measurement of rise or fall (vertical height) of the land. Slope can be expressed as either a ratio or percentage. A 3:1 ratio means there are three feet of length for every foot of rise. The percentages are expressed as the number of feet of rise or drop in 100 feet of distance. See Figure 1.1.

Figure 1.1 - Measuring Slope



Slope is an important factor in the design and construction of a landscape. Any slope over 20 percent would require changes to the land were it to be used. It is very important because of drainage considerations.

Family Needs - Analysis of the family needs must be seriously considered. If the landscape design cannot fulfill a family's needs, it will be of little value to them. Factors to consider on a checklist of family needs should be:

1. Age, sex, and hobbies of each family member
2. Personal plant preferences (likes, dislikes, allergies)
3. Amount of time available for maintenance
4. Whether home is a permanent or temporary residence
5. Location of service areas; e.g., trash, greenhouse, or dog kennel
6. Additions to existing buildings; decks, patios, or a swimming pool

Major Use Areas

After the evaluations of the site and client's needs, the design can be separated into three major use areas: public, private, and service. See

Figure 1.2 - Landscape Slopes for Common Landscape Applications

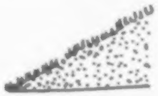
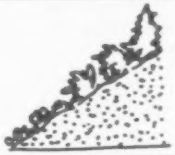
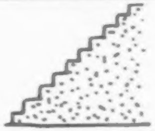
Illustrated Example	Percent of Slope		Landscape Component
	Allowable	Ideal	
	1/2% to 3%	1/2% to 2%	Sitting areas, patios, decks
	1% to 5%	2% to 3%	Lawns
	1% to 8%	1% to 4%	Walks
	1% to 11%	1% to 11%	Driveways and ramps
	Up to 33%	10-20%	Banks planted with grass
	20-50%	20 to 33%	Banks planted with groundcovers and shrubs
	30-65%	33% to 50%	Steps or terracing will be required

Figure 1.3 - Three Major Use Areas

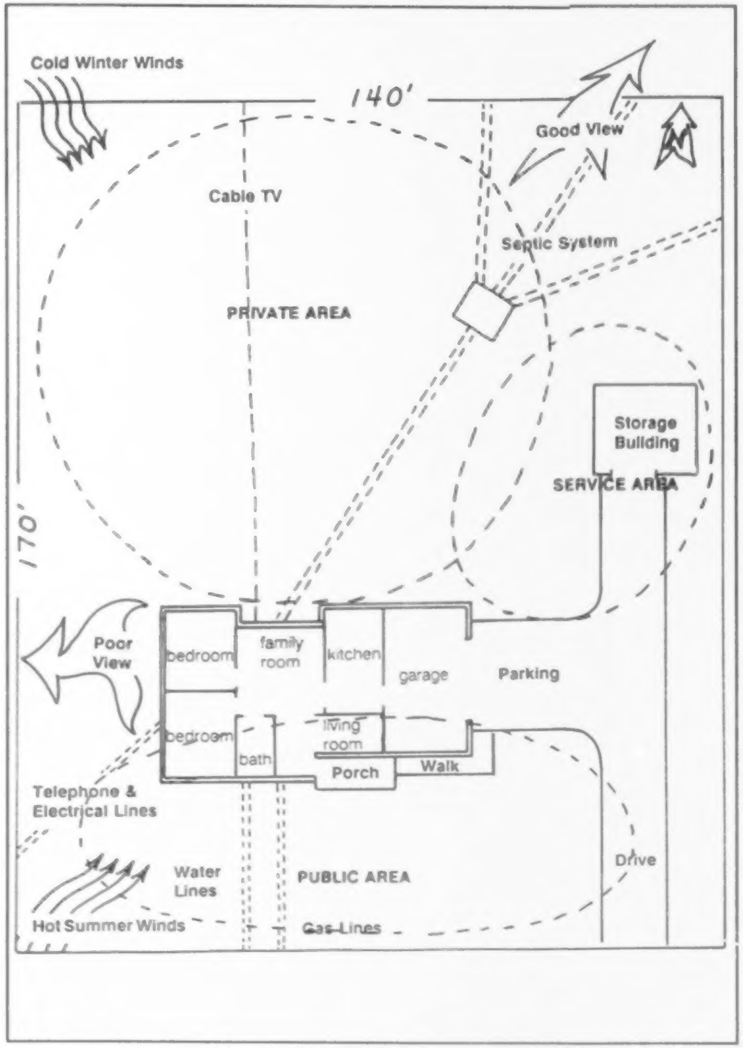

Cold Winter Winds
140'
Good View
Cable TV
Septic System
PRIVATE AREA
Storage Building
SERVICE AREA
170'
Poor View
bedroom
family room
kitchen
garage
Parking
bedroom
living room
bath
Porch
Walk
Telephone & Electrical Lines
Water Lines
PUBLIC AREA
Drive
Hot Summer Winds
Gas Lines

Figure 1.3. The public area is the area of the site which can be seenby the public at all times. Generally, the public use area will be around the front of the house. The private area is for family use. Usually the private use area will be the back yard or side yards of the site. The service or utility area functions as a trash area, compost pile, or place for a clothesline. Usually the service use area is in a side yard or in a screened section of the private area. A site does not necessarily include all of the major use areas, nor is it limited to one use area; a site may include as many major use areas as the client desires.

After the areas are mapped, circulation routes may be added. Circulation includes the movement of people and vehicles on the site using driveways, sidewalks, walkways, and footpaths.

Zoning Regulations

Zoning regulations are very important to consider in landscape design, particularly if any construction (e.g. decks or patios) will be planned. These zoning regulations are created with safety in mind. Each city, town, or individual subdivision will have unique, specific, zoning regulations which can be found at the local city hall.

Summary

Landscape design is an art combined with practical science that produces a unified, working composition. Site and adjacent area evaluation aids the designer in the creation of the landscape design. The design is written and drawn on paper in order to convey ideas and present the plan to a potential client for consideration. When a plan is being considered, factors such as site analysis and analysis of family needs must be considered. There are three major use areas; public, private, and service; that can be designed. Also, zoning regulations must be considered when designing a landscape plan.

Credits

Hannebaum, Leroy. Landscape Design: A Practical Approach. Reston, VA: Reston Publishing Co., 1981.

Ingels, Jack E. Landscaping. 3rd ed. Delmar Publishing Inc., 1988.

Landscape Design: A Student Handbook. University Park, PA: Pennsylvania State University.

Residential Landscape Design. Manhattan, KS: Cooperative Extension Service, Kansas State University.

Information

A base map is a drawing of existing features, on the site such as buildings and vegetation that are plotted on graph paper and drawn to scale. A base map contains a lot of useful information. It indicates the north direction with an arrow as well as provides accurate placement information of existing vegetation, buildings, and other structures. Other information included on a base map might be good and poor adjacent views, sunrise and sunset positions, water drainage, or location of utility lines for gas, electricity, telephone, and water. All information will be marked with measurements in terms of feet and inches.

Structure Locations

A rough draft is drawn while stepping-off and measuring all structures for the base map. The base map is oriented to a currently, existing line, such as a road or a marked boundary. Measure the house from this existing road or boundary line. Step-off the circumference of the entire house. Always remember to keep the tape measure taut and level. Sight-project lines from the sides of the house to use as baselines. The baselines are used at right angles to mark off other features. After the house has been drawn on the rough draft; measure other existing buildings, features, trees, shrubs, flower beds, walkways, and driveways; and draw them in.

Tools and Equipment

Tools and equipment are used by the landscape designer to draw the base map in order to effectively present information and convey design ideas to the client. Landscape designers will use a variety of tools and equipment when drawing a base map. Primary materials used include the following:

1. Various types of pencils are needed. Hardness or softness of lead pencils determines line quality or thickness in a drawing. Pencil selection should include a sharp, fine lead, number two pencil. They are used for sketching ideas and guideline layouts.
2. Tracing paper or graph paper is used for preliminary thoughts, diagrams, or even initial design ideas. 11" x 17" is the suggested size.
3. Drafting tape is used to secure the paper while drawing.
4. Sketch paper or a pad is used for original drawings done in either pencil or ink.
5. An eraser is another necessary item.

Supportive drawing equipment is also needed:

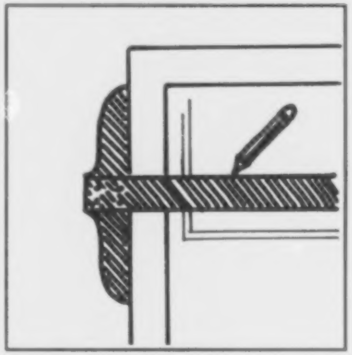


Figure 2.1 - T-Square

1. A drawing table or drafting board with a squared surface that aligns paper squarely and securely is required.
2. A T-square or parallel-rule is used to draft lines that are parallel to the drawing board's square edge, producing horizontal lines. See Figure 2.1.
3. Triangles are used for vertical and diagonal lines.

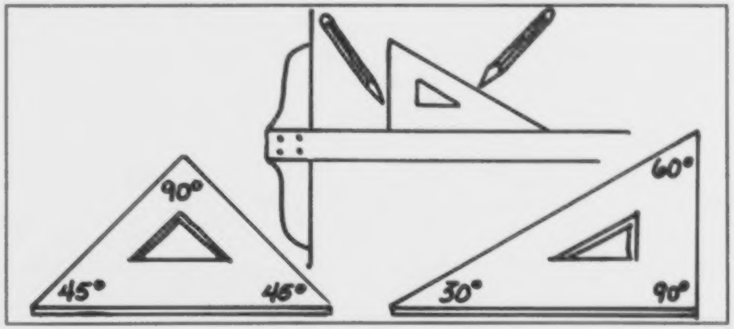
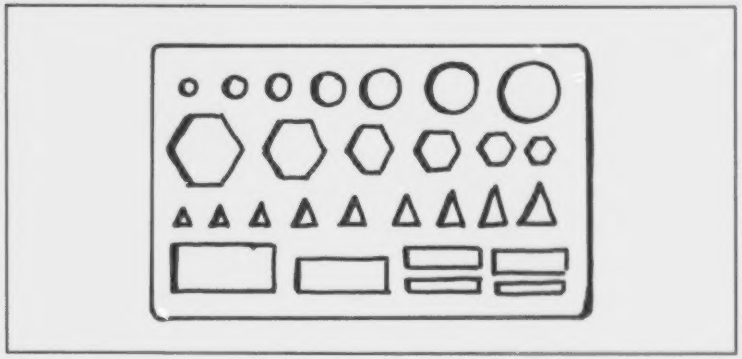


Figure 2.2 - Triangles

Triangles come in many sizes: 30, 45, 60, and 90 degree angles. The most common is the 30 degree angle. See Figure 2.2.

4. Templates are used to help quickly draw shapes, such as circles, to represent trees or shrubs. See Figure 2.3.
5. Lettering guides are horizontal guidelines used for lettering.

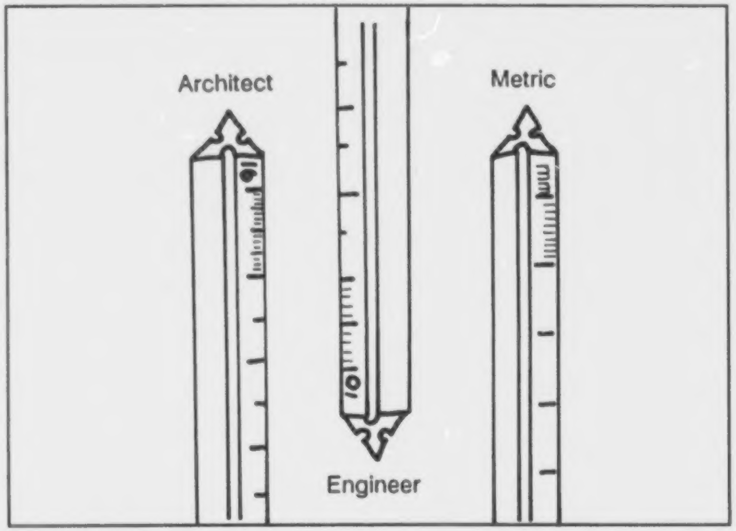
Figure 2.3 - Template



Scales

Scale is very important when drawing a base map. The scale used for a base map is the absolute, not the proportion scale. The absolute scale is used to draw a representation of the actual size of a structure drawn to scale. The proportion scale is used to draw structures in proportion to other structures. When drawing a base map, use the largest scale possible in order to fill a full sheet of graph paper.
There are three different types of absolute scales that can be used in drawing a base map. They are the architect's scale, the engineer's scale, and the metric scale. See Figure 2.4.

Figure 2.4 - Scales



The architect's scale is a foot-long rule which includes the following eleven scales: 1/16":1', 1/8":1', 1/4":1', 1/2":1', 3/8":1', 3/4":1', 1":1', 3/16":1', 3/32":1', 1 1/2": 1', and 3":1'. An architect's scale is commonly used for construction drawings. An engineer's scale is also a foot-long rule which includes six scales that are divided into 10, 20, 30, 40, 50, or 60 parts per inch. For example, in a 1/10 scale one inch on the plan equals 10 feet on the site. This scale is mainly used only for large landscape designs. Recommended scales for most residential work are either 1":10' (engineer's scale) or 1/8":1' (architect's scale). The metric scale is similar to the engineer's scale, except that the scale is given in ratios related to meters, such as: 1:1000, 1:125, 1:200, 1:500, 1:175, and 1:100. For example, 1:500 represents divisions of 500 equal parts to one meter.

Summary

A base map shows the physical information of a site that is plotted and scaled. The information on a base map should include boundary lines, existing plant material, buildings, driveways, walkways, and all utility lines. Tools and equipment are necessary for drawing a base map. Some of these are a scale, pencils, ink, sketch pads, T-squares, and triangles. Either architect's, engineer's, or metric scales are used for design. The architect's scale is the one most commonly used.

Credits

Hoover, Normal K. and Elwood M. Juergenson Approved Practices in Beautifying the Home Grounds. Danville, IL: Interstate Printers and Publishers, 1973.

Pierceall, G.M. Residential Landscapes. Reston, VA: Prentice-Hall Co., 1984.

Residential Landscape Design. Manhattan, KS: Cooperative Extension Service, Kansas State University.

A landscape designer uses graphic symbols to communicate ideas. Symbols are drawings representing overhead views of design features. The symbols must be understood to accurately interpret a landscape plan.

Symbols

Various graphic symbols are used to represent design features, such as size, shape, texture, and detail. Normally, variations of a circle are used to designate trees and shrubs. Each designer will vary symbols, but, in general, symbols are similar.

Variations of circles - The diameter of a circle will represent the mature size of each plant. Remember, landscape designs are usually created to represent the mature size of all vegetation. A dot or an X in the center of a circle shows the exact placement of a tree or shrub. Common symbols representing deciduous trees and shrubs and evergreen trees and shrubs are illustrated in Figure 3.1. Trees and shrubs can be drawn side by side by separating the symbols, or they can be drawn as mass plantings by merging them.

Variations of lines - Other features of a landscape plan, such as ground covers, mulch, vines, flowers, and turf, are represented by lines or variations of lines. See Figure 3.2. Changes in line patterns are used to designate differences between these features.

Other features found on a landscape plan are the written scale, directional indicator, plant list, and lettering. North is usually oriented upwards in a landscape plan. See Figure 3.3.

Figure 3.2 - Ground Cover Patterns

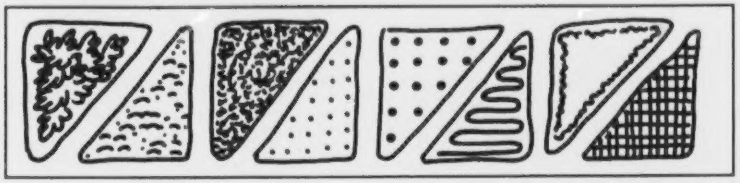


Figure 3.1 - Common Symbols of Trees and Shrubs

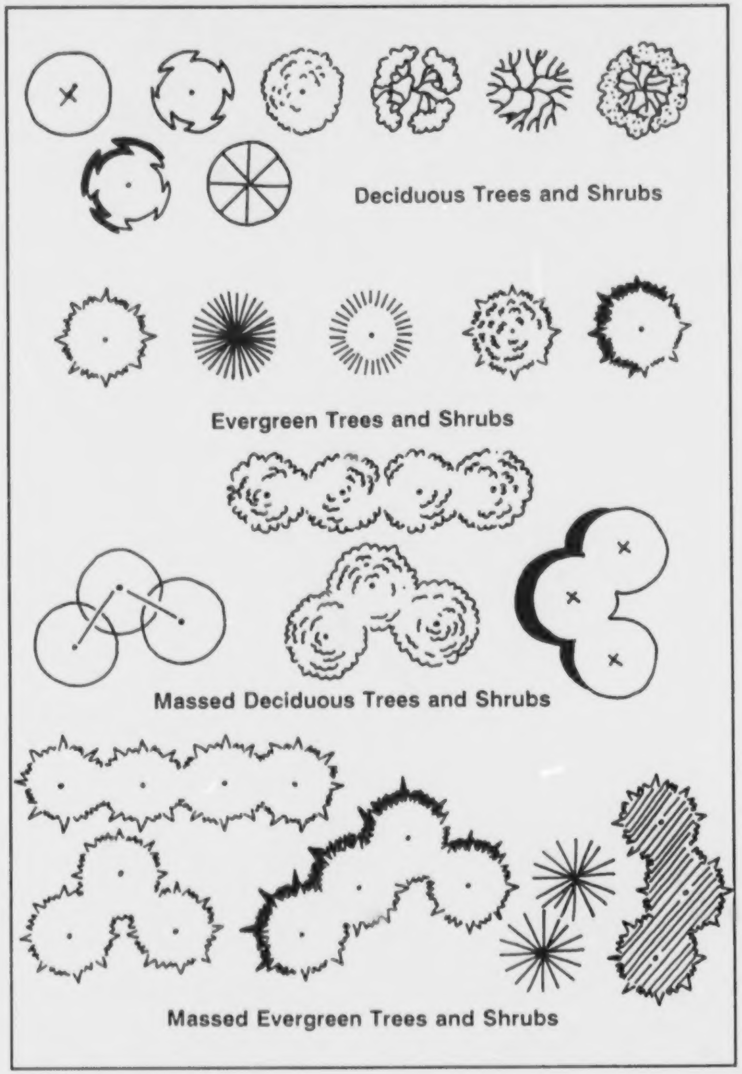
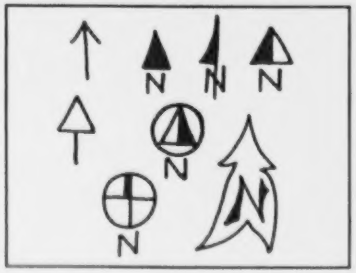

Deciduous Trees and Shrubs
Evergreen Trees and Shrubs
Massed Deciduous Trees and Shrubs
Massed Evergreen Trees and Shrubs

Figure 3.3 - North Symbols



Plant list - Plants can be labeled directly on the landscape plan, or if a plan is already filled with information, they can be found on a plant list. A plant list is an information table for botanical names, quantities, sizes, and conditions of plants. Plants in the design will either have a key number or letter to identify them in the plant list. See Figure 3.4.

Figure 3.4 - Plant List

Key	Common Name	Botanical Name	QTY	Size	Notes
1	European White Birch	Betula pendula	1		
2	Red Maple	Acer rubeum	2		
3	Eastern Redbud	Cercis canadensis	3		
4	Sugar Maple	Acer saccharum	2		
5	Skyline Honeylocust	Gleditsia triacanthos 'Skyline'	7		
6	Radiant Crabapple	Malus 'Radiant'	3		
7	Blue Rug Juniper	Juniperus horizontalis 'Wiltoni'	7		
8	Pin Oak	Quercus palustris	1		
9	Mugho Pine	Pinus mugo 'Cimpacta'	1		
10	Japanese Barberry	Berberis thunbergii	6		
11	Gold Drop	Potentilla friticosa	5		
12	Potentilla Kobold Barberry	Berberis thumbergi 'Kobold'	2		
13	Common Flowering Quince	Chaenomeles speciosa	13		
14	Kalm St Johnswort	Hypericum kalmianum	11		
15	Pfitzer Juniper	Juniperus Chinesis pfitzerana	14		
16	Hall's Honeysuckle	Louicera japunica 'Halliana'	37		
17	Periwinkle	Vinca minor 'Bowles'	62		

Lettering - There are many styles of lettering; all lettering in a design should be a consistent style for ease of reading. All lettering should be of uniform height throughout the design plan. The four methods of lettering follow.

1. Using waxed press-on letters is the quickest and easiest method, but they can be expensive and will crack with age. There are many styles of press-on letters such as Helvetica, Gothic, and Universal.
2. Using a lettering tape machine is similar to typing letters on a clear tape.
3. Lettering guides are templates of letters.
4. Freehand is the most common method of lettering. The four methods of freehand lettering follow.
   a) Basic block letters
   b) Distorted block letters
   c) Slanted block letters
   d) Slanted, distorted block letters

Title block - A title block contains general information about the design itself. See Figure 3.5. The title block is usually found at the lower,

Figure 3.5 - The Title Block

LANDSCAPE PLAN
THE ANDERSON RESIDENCE
OSAGE BEACH, MISSOURI
C. ANDERSON, DESIGNER MAY 1990

right-hand corner of the landscape plan. It will include information such as the title of the project, the client's name, the designer's name or initials (or the name of the landscaping firm), the date the plan was completed, and the address of the property designed.

Additional types of drawings - Other information may be illustrated on a landscape plan through an elevational drawing, a perspective view drawing, or a construction-detail drawing. An elevational drawing shows height, width, and form of the suggested design. See Figure 3.6. A perspective view is three-dimensional. See Figure 3.7. A construction-detail drawing is an enlarged scale of a given area for more accurate labeling. See Figure 3.8. These three drawings aid in accurately communicating the designer's ideas to the client.

Figure 3.6 - An Elevational Drawing

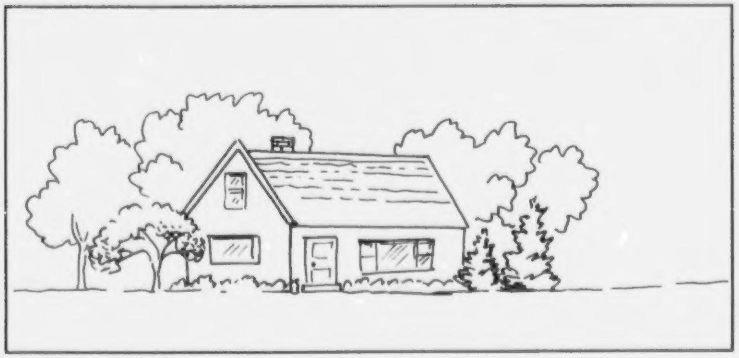


Figure 3.7 - A Perspective Drawing

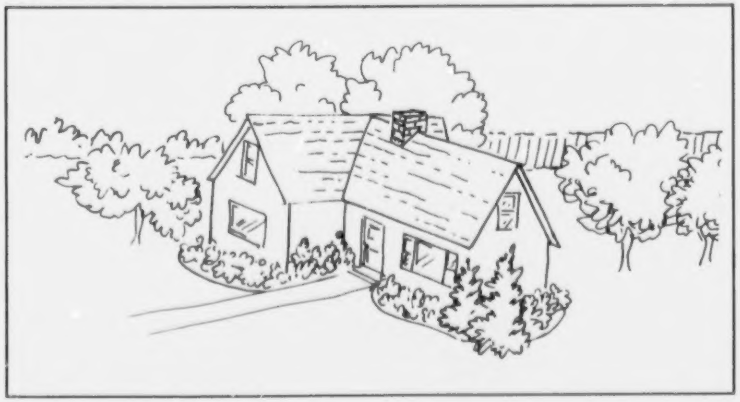
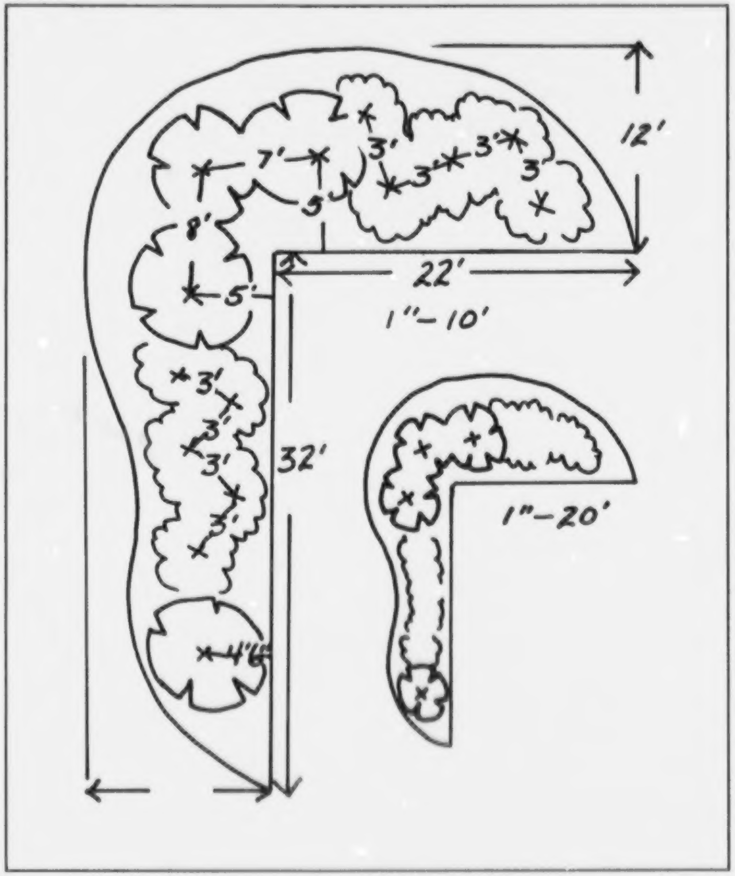


Figure 3.8 - Construction - Detail Drawing



Summary

In order to interpret a landscape plan accurately, the symbols used on the plan must be easy to understand. A variation of a circle will represent a deciduous or evergreen tree or shrub. Other features are represented by various lines. Lettering is important because it clarifies the plan. A title block is usually placed on the lower right hand corner of the plan and it contains information about the client and the designer. Legibility and neatness of a landscape design are important factors to consider in pleasing the client as well.

Credits

Hannebaum, Leroy. Landscape Design: A Practical Approach. Reston, VA: Reston Publishing Co., 1981.

Ingels, Jack E. Landscaping. 3rd ed. Delmar Publishing Inc., 1988.

Margraff, Alexis. Landscape Drawing Techniques. Ithaca, NY: Cornell University Instructional Materials Service.

Pierceall, G.M. Residental Landscapes. Reston, VA: Prentice-Hall Co., 1984.

Residential Landscape Design. Manhattan, KS: Cooperative Extension Service, Kansas State University.

Trees are large, woody plants that have one or more trunks topped by a canopy of leaves. They define vertical space and create a roof for people. Trees are the largest and most dominant element in the landscape. They set the theme for the entire landscape; and, depending on the type used and the location; they determine to a great extent what other plantings are appropriate. When selecting a tree, a landscaper should first decide where a tree is needed and what its purpose is. Then the landscaper can decide which type of tree to plant.

Purposes of Trees in the Landscape

Trees create climatic, aesthetic, economical, and psychological effects.

Climate - Trees and other plants help to purify the air, reduce noise levels near highways or other noise sources, and help control erosion. Other climatic influences include; increasing or decreasing wind; cooling air through transpiration; and blocking the direct rays of the sun, which reduces room temperature inside the house and on the ground by shading. They also obstruct, deflect, and filter air flow for the benefit of small plants, animals, and property.

Aesthetics - Trees provide a ceiling for an outdoor room and create a feeling of intimacy, in addition to other aesthetic effects listed below.

1. Trees provide a variety of colors, forms, textures, and patterns.
2. They frame and accentuate the design and structural detail of a house.
3. They soften or compliment architectural lines.
4. They provide a welcoming feeling to a building entrance.
5. They frame views, provide focal points, and form vistas.
6. They spark up the monotony of pavement and masonry.
7. They provide play areas.
8. They provide shade to a terrace or patio.
9. They screen out unsightly views.
10. They provide privacy for outdoor activities.
11. They provide pleasant fragrances and peaceful sounds from rustling leaves.
12. They provide a flowering focal point.
13. They provide seasonal variety.
14. They help new residences look established; replacing a raw, unfinished look.
15. They provide a backdrop for other plant material.
16. They attract birds.

Economic value - Trees can affect the economic value of a property. They can increase the property value by $27.50 to $33.00 per square meter of shade they provide. Damaged trees can be claimed on some insurance policies based on the amount of shade they once provided, which is a loss if the tree is destroyed.

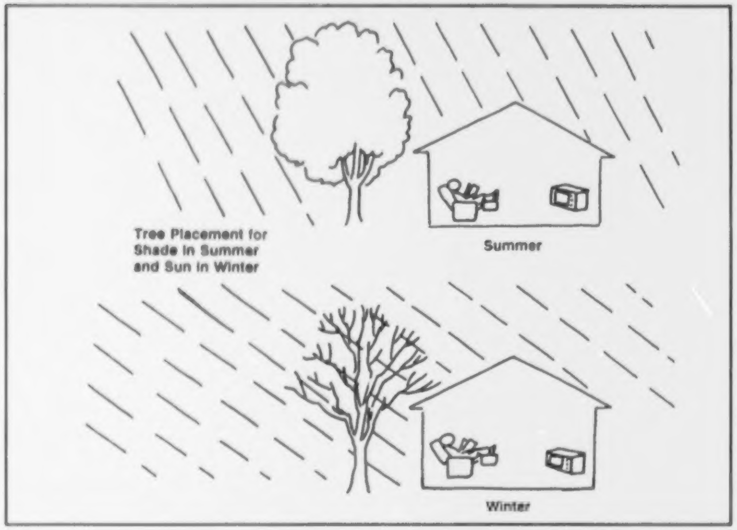
Psychological effect - Trees can have a psychological influence on human behavior. Studies show that trees and other plants help increase social activity and good community relations. In industry, they increase productivity and lower absenteeism.

Purposes of deciduous trees - The color, line, texture, and pattern of deciduous trees change with the seasons. To conserve energy, during the winter; deciduous, not evergreen trees, should be placed on the southern exposure of a house. This allows the sun's rays to filter through and heat the house. See Figure 1.1.

Purposes of evergreen trees - Evergreen trees are used as screens, sound barriers, to provide privacy, and as background for other plant materials. On the north side of the house, they serve as a windbreak to keep cold winds from causing heat loss in a house. There is only a slight seasonal color change, and in addition some produce attractive flowers and fruits.

Trees as well as other plants are important factors in energy conservation. They help control temperature, solar radiation, and wind.

Figure 1.1 - Tree Placement for Energy Conservation



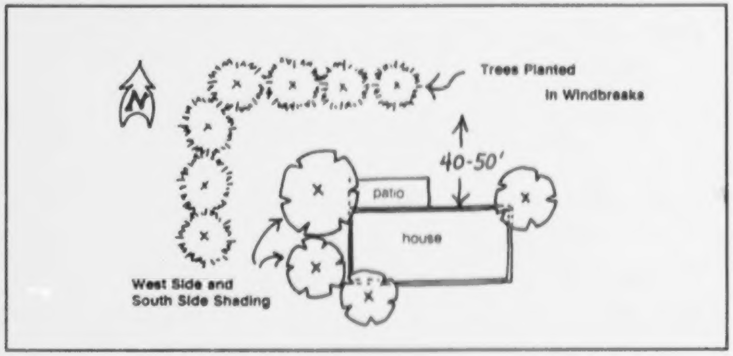
Using trees for wind protection and as windbreaks can help reduce winter fuel consumption from 10-25 percent.

Windbreaks - A windbreak reduces air movement around the home, slowing heat loss from walls and ceilings of buildings. Windbreaks can also change the direction of wind movement. They either direct the wind up and over the house, so wind does not cause heat loss, or direct cool summer breezes through a house. A windbreak is a row of trees planted on the side of the house that faces prevailing winds. In Missouri, the winter winds blow strongest from the Northwest, therefore trees should be planted on that side of the house. Windbreaks are planted in a U or L shape. Where space allows, windbreaks should be planted 50 feet beyond each corner of the area to be protected. Remember that snow can drift one to three times the height of the tree; so trees should be planted where snow drifts do not form on roads, walks, and driveways. Also, select trees that will mature to the desired height.

Windbreaks are formed by planting one to three rows of trees and shrubs. If planting only one row of trees, pines should be used. A row of low-growing evergreen shrubs should be planted to fill in space near the ground since pines mature and thin out at the bottom. The trees should be planted six to eight feet apart in a one row windbreak. If planting four to five rows, deciduous trees should be used. The trees should be spaced 12 to 20 feet apart and staggered.

The most effective windbreaks consist of both deciduous and evergreen trees. This allows some wind to pass through, preventing the formation of a vacuum while still directing wind over the property. See Figure 1.2.

Figure 1.2 - Windbreak



A windbreak is also designed to lift wind up and over the entire property, with wind eventually reaching the ground again. If the windbreak is too narrow and short, the wind will reach the ground again prematurely. So, instead of excluding wind from the entire lot, it is merely transferred to another space on the lot. The height and width of a windbreak must be sufficient to lift the wind up and over the entire lot. On a residential lot, too much of the lot would be taken up by the windbreak. Therefore, wind protection is a better choice than a windbreak.

Wind protection - Wind protection decreases the wind's force as it moves through the landscape. Fences and walls, in combination with plants in front of them, provide good wind protection. A fence alone allows the wind to swoop over the top and drop quickly to the ground on the other side. Foundation plants create dead air-space between the house and the plants, therefore insulating the outer wall of a house.

Tree Selection Considerations

Trees are usually permanent. Many will live for 100 years or more. Because of this, care must be used in selecting the best species for each situation. An inappropriate tree in a poor spot will detract from the whole landscape.

What to avoid - Avoid trees that are susceptible to storm damage. For example, faster growing trees have weaker wood. Conifers are not as strong, but their form and branch structure help to compensate. Trees susceptible to pests and diseases, or those that produce unwanted seeds or fruit, are also poor choices.

Plant site conditions - The choice will often depend on existing conditions of the planting site. These include; room for top and root growth, soil type, pH, and subsurface drainage.

Plant characteristics - There are characteristics of a plant that should be considered before selecting it for the landscape. These are as follows.

1. Hardiness of plant and the hardiness zone of the desired location
2. Height at maturity
3. Width at maturity
4. Shape
5. Form
6. Growth habit
7. Branching habit
8. Rate of growth
9. Water, light fertilization, and temperature requirements
10. Leaf color (in all seasons)
11. Flower color, types, and time of bloom
12. Fruit type, color, and time of production
13. Texture
14. Diseases, insect problems, and control methods
15. Pruning requirements
16. Ability to be transplanted
17. Life span
18. Availability
19. Function in landscape
20. Salt tolerance
21. Spacing
22. Maintenance - leaf, bark, flowers, fruit drop

Street trees - The best street trees are those with high branching and spreading habits. When planting street trees, a few extra factors should be considered. They are as follows.

1. Ability to permit the free movement of pedestrians and vehicles
2. Ability to not interfere with overhead or underground utility installations
3. Ability to avoid interference of traffic sighting distance
4. Ability to provide desired shade and appearance
5. Suitability to available space
6. Hardiness and maintenance requirements

Selection Criteria for Common Trees

Specific criteria for the selection of common shade, flowering, and evergreen trees are found in the tables provided at the end of this lesson.

Summary

Trees are a very important part of the total landscape design. They set the theme for the entire landscape. They serve many purposes which include; increasing climatic, aesthetic, economic, and psychological value of a landscape. Each tree has unique characteristics that should be considered before selecting it for a location in the landscape. If they are not considered, trees may detract from a landscape rather than benefit it.

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G06800: Selecting Landscape Plants: Shade Trees

SHADE TREES

Acer rubrum - red maple

Acer saccharum - sugar maple

Betula nigra - river birch

Betula pendula - European white birch

Fraxinus Pennsylvania - green ash

Gleditsia triacanthos inermis - honey locust

Liquidambar styraciflua - sweet gum

Liriodendron tulipifera - tulip tree

Plantanus occidentalis - sycamore

Quercus palustris - pin oak

Tilia cordata - littleleaf linden

Table 1.1 - Shade Tree Selection

COMMON NAME	BOTANICAL NAME	HEIGHT	WIDTH	FORM	GROWTH RATE	HARDINESS ZONE	USE IN LANDSCAPE	TEXTURE
Red Maple	*Acer rubrum*	40-60'	25-50'	upright to round	medium to fast; space 30' apart	3	specimen; street; patio; downtown	medium
Sugar Maple	*Acer saccharum*	40-70'	50-60'	upright, oval	slow to medium; space 30' apart	3	specimen; street, residential or larger	medium
River Birch	*Betula nigra*	30-50'	30-50'	upright, oval; rounded with maturity	medium to fast; space 30' apart	4	specimen; residential or larger effect; groupings	medium to fine
European White Birch	*Betula pendula*	25-40'	10-15'	oval, graceful, pendulous branches	medium; space 12' apart	8	good for narrow spaces; residential or larger; specimen	fine
Green Ash	*Fraxinus pennsylvanica*	50-60'	40-50'	round to oval; irregular with maturity	fast; space 40' apart	3	street, quick effect	medium, coarse
Honey Locust	*Gleditsia triacanthos inermis*	30-60'	30-50'	oval	medium to fast; space 30' apart	4	street; raised planters; thornless & fruitless varieties are good for downtown areas & lawn trees	coarse, winter pattern
Sweet Gum	*Liquidambar styraciflua*	60-70'	30-40'	oval to irregular	slow to medium; space 30' apart	5	specimen; street, residential or larger	medium to coarse
Tulip Tree	*Liriodendron tulipifera*	60-90'	30-50'	oval, pyramidal	fast; space 40' apart	4	large scale design	medium to coarse
Sycamore	*Platanus occidentialis*	70-100'	70-100'	oval to irregular	fast; space 40' apart	4	large scale; parks and large estates	coarse
Pin Oak	*Quercus palustris*	60-70'	40-50'	pyramidal; lower branches hang down	medium; space 40' apart	4	residential or larger; specimen; useful urban tree	medium to slightly coarse
Littleleaf Linden	*Tilia cordata*	40-60'	35-40'	upright; oval to pyramidal with maturity	medium; space 30' apart	3	dense shade; street; residential or larger	medium

Table 1.1 - Shade Tree Selection continued

COLOR (LEAF)	FLOWERING COLOR, LENGTH OF BLOOM	FRUITING TIME/TYPE	FERTILIZER REQUIREMENTS	SOIL CONDITIONS	WATER REQUIREMENTS	LIGHT REQUIREMENTS
medium green; yellow to red in fall	small red colorful flowers in spring	bright red; samaras in late spring	medium	slightly acidic; chlorotic in highly alkaline soils	dry to wet	sun to part shade
dark green; yellow to red in fall	yellow flowers in May	greenish-yellow, Samara; early April; semi-attractive	medium	prefers acidic soil; well-drained	medium to moist	sun to part shade
medium green; yellow in fall	long pistillate	small nutlet	medium	slightly acidic; tolerates many	wet to dry; first to show moisture stress	sun to part shade
glossy green; paler underside; yellow in fall	not important	brown cone-like in summer	medium	medium drainage	high moisture	sun
medium to dark green; paler underside; yellow in fall	not important	2"; light tan samara in clusters in early fall	medium	wide range; acidic to alkaline	dry to wet; drought resistant	sun
bright green; yellow in fall	not important; greenish pea-like; fragrant	fruiting varieties have 8-18" long twisted brown pods, which persist into winter		wide range; acidic to alkaline	dry to wet; drought tolerant	sun to part shade
medium green; yellow, red, or scarlet in fall	not important	brown spiny balls that persist into winter	subject to chlorosis in high alkaline soil	wide range, acidic to alkaline; best in rich clay or loam	dry to wet	sun to shade
shiny green; yellow in fall	large yellow-orange tulip-like flowers in early summer	cone-like fruits that persist into winter	medium	well-drained; perfers acidic soils	medium	sun
medium green; tan in fall	not important	brown 1 1/2" balls that persist into winter	medium	prefers deep rich soil, but will tolerate many soils including alkaline	moist	sun to part shade
dark green; red or brown in fall; foliage persists into winter	not important	light brown (acorn) nut; single or cluster; 1/2" long	subject to iron chlorosis	does not tolerate alkaline soils	prefers moist, but will tolerate dry soils	sun to part shade
dark green; yellow in fall	very fragrant yellow to white flowers in late June	seeds on ribbon-like leaf		wide range of soil; will tolerate alkaline soil if moist; tolerates poor soil	prefers moisture; not tolerant of drought	sun to part shade

Table 1.1 - Shade Tree Selection continued

COMMON NAME	TEMPERATURE REQUIREMENTS	TRANSPLANT-ABILITY	DISEASE PROBLEMS	INSECT PROBLEMS	PRUNING METHOD AND TIME	SPECIAL CONSIDERATIONS	UNIQUE CHARACTERISTICS
Red Maple	tolerates city heat and glare	easy; B & B and bareroot; spring		leaf hoppers	not important	good replacement for Silver Maple	colorful fall color
Sugar Maple	to zone	easy; B & B	leaf scorch; verticillium wilt		not important	not good in containers or in pollution; attractive winter branching	colorful fall color
River Birch	to zone	easy	mildew; woody decay; leaf spot; dieback	leaf miner; bronze birch borer; aphids	not important	light shade	showy peeling bark; good winter branch habit
European White Birch	to zone	easy in spring	none serious	bronze birch borers; aphids; leaf miner	summer or fall; spring pruning causes bleeding	litter problem; not recommended because of bronze birch borer	especially interesting white bark
Green Ash	to zone	easy	rusts and cankers; many others	borers and scale; many others	in fall	roots clog drains; wildlife food; somewhat tolerates salt	"Marshall Seedless" variety has no seeds; others create litter
Honey Locust	to zone	easy	leaf spot; cankers; rust	borers; webworm; spider mites	thin young trees of new growth; prune in fall	tends to be overused; salt, pollution, and wind tolerant; low maintenance of leaf drop	interesting branch habit; filtered shade allows grass to grow; thornless cultivars are recommended
Sweet Gum	to zone	B & B in spring; difficult	bleeding necrosis; leaf spots	webworm; scales	not important	seed balls cause litter; not good in city	colorful fall color; seed balls give winter interest
Tulip Tree	to zone	B & B; spring	leaf spot; sooty mold; canker	aphids	not important	roots can be invasive; not tolerant of air pollution; weak-wooded; flowers are high in the tree	massive stately tree
Sycamore	to zone	easy	anthracnose; witches broom; leaf spots	aphids; scale bug; sycamore plant tussock moth	not important	don't use as street tree--too messy; use London Plane tree instead, because it is anthracnose resistant	exfoliating bark; colorful winter trunk, branches, and hanging balls; attractive flaking bark
Pin Oak	to zone	easy	galls; iron chlorosis	none serious	low branches frequently require pruning	winter foliage blocks sun heat; don't use near streets or sidewalks due to low branches	good for city conditions; interesting growth habit
Littleleaf Linden	tolerates heat	easy	leaf blight; cankers; powdery mildew	aphids; scales; linden mite; borers	can be pruned to hedge	pollution tolerant	fragrant flowers attract bees

FLOWERING TREES

Albizia julibrissim - mimosa

Cercis canadersis - eastern redbud

Cornus florida - flowering dogwood

Crataegus phaenopyrum - Washington hawthorne

Koelreuteria paniculata - golden raintree

Magnolia soulangiana - saucer magnolia

Malus species - flowering crabapple

Pyrus calleryana "Bradford" - Bradford pear

Table 1.2 - Flowering Tree Selection

COMMON NAME	BOTANICAL NAME	HEIGHT	WIDTH	FORM	GROWTH RATE	HARDINESS ZONE	USE IN LANDSCAPE	COLOR (LEAF)
Mimosa	*Albizia julibrissin*	25-35'	25-35'	broad-spreading, vase shape	medium	6	residential; not much value	medium green; yellow in fall
Eastern Redbud	*Cercis canadensis*	20-25'	15-20'	rounded	medium; space 15' apart	4	specimen; under-story; shrub border; groupings	dark green; yellow in fall
Flowering Dogwood	*Cornus florida*	20-30'	15-20'	semi-rounded	slow to medium; space 12' apart	4	specimen; under-story residential; naturalistic; grouping	dark green; brilliant red in fall
Washington Hawthorn	*Crataegus phaenopyrum*	25'	15-20'	oval to round; upright	medium; space 10' apart	4	specimen; mass barrier; accent	dark green; reddish in spring; yellow in fall
Golden Raintree	*Koelreuteria paniculata*	20-40'	20-25'	rounded, spreading	medium; space 20' apart	5	residential; patio/terrace; street tree	green; yellow in fall
Saucer Magnolia	*Magnolia soulangiana*	20-25'	15-20'	oval to rounded; irregular with maturity	medium; space 12' apart	5	specimen	green; yellow to brown in fall
Flowering Crabapple	*Malus species*	15-25'	20-25'	oval to spreading	medium; space 15' apart	4	specimen; naturalistic; grouping; residential or larger	green to red; yellow to red in fall
Bradford Pear	*Pyrus calleryana "Bradford"*	30-50'	20-35'	pyramidal to oval	medium; space 20' apart	4	specimen; street; residential scale	glossy green; purple in fall

Table 1.2 - Flowering Tree Selection continued

FLOWERING COLOR, LENGTH OF BLOOM	FRUITING TIME/TYPE	TEXTURE CHARACTERISTICS	SOIL CONDITIONS	WATER REQUIREMENTS	FERTILIZING REQUIREMENTS	LIGHT REQUIREMENTS	TEMPERATURE REQUIREMENTS
showy pink powder puffs in summer	not important	fine	well-drained, alkaline soil	medium	medium	full sun	heat tolerant
pink flowers in early spring before leaves	3" brown pods in fall that persist into winter; legume	medium to coarse	wide range; well-drained, acidic to alkaline soils	moist to drought resistant	medium	sun to part shade; blooms best in full sun	to zone
white or pink showy flowers in mid-May	orange to red fruit in clusters, persist into winter	medium	well-drained acidic soil; add organic matter	medium	medium	part shade to shade	to zone
white 1/2" flowers in mid-June	red-orange clusters in fall that persist into winter	fine-medium	wide range, well-drained, acid to alkaline	dry to moist	medium	sun to part shade	to zone
showy bright yellow panicles in summer	clusters of papery capsules that persist into winter	medium	wide range	drought resistant	medium	best in sun	tolerates low winter temperature and wind
showy, pink to white saucer-shaped flowers	not important	medium-coarse	slightly acidic, loose	medium	medium	sun to part shade	protected location helps prevent flower bud frost damage
white to red flowers in early spring	yellow or red pome fruit in late summer and fall	medium	well-drained slightly acidic soil	medium	medium	sun to part shade	to zone
white flowers in early spring before leaves	small 1/2" fruits in fall; not showy	medium	wide range	medium to dry	medium	sun	to zone

Table 1.2 - Flowering Tree Selection continued

COMMON NAME	TRANSPLANT-ABILITY	DISEASE PROBLEMS	INSECT PROBLEMS	PRUNING METHOD AND TIME	SPECIAL CONSIDERATIONS	UNIQUE CHARACTERISTICS	OTHER COMMENTS
Mimosa	difficult	vascular wilt	webworm	prune wide-spreading branches to relieve weight	not a quality landscape plant; winter kills	foliage folds at night; showy flowers	not suited to northern climates; short life span
Eastern Redbud	medium; B & B	canker; leaf spot; verticillium	borers; scales; leaf hoppers; leaf rollers	prune dead branches	better related to cool, moist climate	persistant fruit in winter; showy flowers	blooms same time as dogwood
Flowering Dogwood	B & B; difficult	fungal wilt; leaf spot	borers	not applicable	subject to winter injury to flower buds	interesting winter branching; 4 seasons of interest	grows wild in Southern Missouri and south; Missouri's state tree; wildlife food
Washington Hawthorn	easy; B & B, early spring, as small tree	cedar Hawthorn rust; fire blight; leaf spots; powdery mildew; scab	lace bug; aphids; borers	winter or early spring	tolerates city conditions	2" thorns	none applicable
Golden Raintree	easy; B & B	none serious	none serious	winter	none important	nice persistant fruit in winter	tolerates air pollution
Saucer Magnolia	difficult, B & B in spring	black mildew; leaf spots; leaf blight	none serious	prune after flowering	blooms best in sun	showy flowers	susceptible to late frost damage
Flowering Crabapple	easy	fire blight; cedar apple rust; apple scab; canker; powdery mildew	scale; borers; aphid	prune after flowering	blooms best in sun	showy flowers	can be grown in espalier or raised planter; many varieties
Bradford Pear	easy; B & B in early spring	none serious	none serious	prune lower branches for down-town walk; spring	tolerates pollution	good fall color; fruit not important; nice in bloom	fairly resistant to fire blight

EVERGREEN TREES

Ilex opaca - American holly

Juniperus virginiana - Eastern red cedar

Magnolia grandiflora - southern magnolia

Picea abies - Norway spruce

Picea pungens "Glauca" - blu[illegible]ce

Pinus nigra - Austrian pine

Pinus strobus - white pine

Pinus sylvestris - Scotch pine

Tsuga canadensis - hemlock

Table 1.3 - Evergreen Tree Selection

COMMON NAME	BOTANICAL NAME	HEIGHT	WIDTH	FORM	GROWTH RATE	HARDINESS ZONE	USE IN LANDSCAPE	COLOR (LEAF)
American Holly	*Ilex opaca*	15-30'	15-20'	pyramidal	slow to medium; space 20' apart	5	specimen; screen; grouping	dull yellow-green
Eastern Red Cedar	*Juniperus virginiana*	30-40'	15-18'	pyramidal to broadly pyramidal	medium; space 12' apart	2	enframement; screen; windbreak; hedge	dull reddish-green
Southern Magnolia	*Magnolia grandiflora*	50-60'	30-40'	pyramidal; rounded in maturity	slow to medium; space 35' apart	7	specimen; large scale; high screen	shiny, dark green; rust colored and pubescent on underside
Norway Spruce	*Picea abies*	40-60'	25-35'	pyramidal	medium; space 25' apart	2	specimen; windbreak; enclosure	bright to medium green
Blue Spruce	*Picea pungens "Glauca"*	80-100'	15-25'	broadly pyramidal	slow to medium	2	specimen; accent; windbreak	gray to blue-green
Austrian Pine	*Pinus nigra*	30-60'	20-40'	pyramidal; oval in maturity	medium	4	specimen; windbreak; screen or grouping	dark green
White Pine	*Pinus strobus*	50-60'	25-30'	pyramidal to irregular; pyramidal in maturity	fast to medium; space 15' apart	3	specimen; screen; mass; background; residential and large scale	bluish to gray-green
Scotch Pine	*Pinus sylvestris*	30-60'	30-40'	irregular pyramidal	medium; slow with maturity; space 25' apart	2	specimen; mass; windbreak; screen	blue-green; yellowish-green in winter
Hemlock	*Tsuga canadensis*	50-70'	20-25'	pyramidal	moderate to rapid; grows fast after established; space 10' apart; closer in hedges	3	tall screen & hedges; specimen; open area or understory tree; north exposure; deep shade	dark green; flat needles

Table 1.3 - Evergreen Tree Selection continued

FLOWERING COLOR, LENGTH OF BLOOM	FRUITING TIME/TYPE	TEXTURE	SOIL CONDITIONS	WATER REQUIREMENTS	FERTILIZING REQUIREMENTS	LIGHT REQUIREMENTS	TEMPERATURE REQUIREMENTS
not important	red berries in October that persist into winter	medium-coarse	fertile, well-drained, acidic	moist to dry	medium	sun to part shade	needs wind protection
not important	bluish-gray berry on female plant	medium	wide range; acidic to extremely alkaline; will tolerate poor soils	dry to moist	low	sun	to zone
large, fragrant white flowers in late spring	grayish-brown cone with red seeds in early fall	coarse	wide range, but prefers slightly acidic	medium to moist; not dry	medium	sun to part shade	protect against wind and extreme cold temperatures
not important	brown cones 5-6" in upper part of tree; pendulous	medium	don't plant on poor sites; sandy, well-drained	moist, humid	good fertility	sun to part shade	not tolerant of hot weather
not important	pendulous, cylindrical brown cone	medium	rich moist	medium; some drought tolerance	medium to high	sun	to zone
not important	cones; 3" long; some in clusters	medium	tolerant of poorly drained and heavy soils	tolerates moist, not wet soil; tolerates some drought	medium	sun	heat resistant
not important	5-6" brown cone; pendant	fine	well-drained; tolerates dry, rocky soil	medium to high	medium	sun	to zone
not important	gray to dull brown rounded cones	medium	well-drained; will tolerate poor dry soil; will tolerate acid soil	low to medium	low to medium	sun	to zone
NA	brown 1/2" cone in fall; slender apex nearly blunt	fine	well-drained; acidic; deep moist loam; rocky bluff or sandy	medium to high; not drought tolerant	medium	sun to part shade; grows best in partial shade	not tolerant of dry winds or prolonged heat

Table 1.3 - Evergreen Tree Selection continued

COMMON NAME	TRANSPLANT-ABILITY	DISEASE PROBLEMS	INSECT PROBLEMS	PRUNING METHOD AND TIME	SPECIAL CONSIDERATIONS	UNIQUE CHAR-ACTERISTICS	OTHER COMMENTS
American Holly	easy; B & B in spring	leaf spot; bacterial blight; twig die back; leaf rot	scale; holly leaf miner; bud moth; whitefly; berry midge	winter holiday season	smaller leaf varieties are better for home and downtown	broadleaf evergreen; spiny leaves	tolerates air pollution; plant 1 male for every 2-3 females
Eastern Red Cedar	easy; B & B	cedar apple rust	bag worms; spider mites	withstands heavy pruning; hedges	very easy to grow; may clash with other foliage colors	narrowleaf evergreen; resistant to phomopsis	tolerates air pollution
Southern Magnolia	difficult; B & B; early spring	none serious	none serious	after flowering	lower branches will help hide dropping leaves	broadleaf evergreen	protect from winter winds and sun
Norway Spruce	easy; B & B	none serious	spider mites; spruce gall-aphids; borers; budworm	tolerates heavy pruning; spring	NA	narrowleaf evergreen; branches droop	much over-planted
Blue Spruce	easy; B & B	none serious	spruce gall-aphids; spruce budworm; spider mites	NA	looses lower branches	narrowleaf evergreen; blue color will detract from other plants	over-used
Austrian Pine	easy	Diplodia tip blight	pine needle; scale	none required; prune candles to shape	tolerates salt and city conditions	narrowleaf evergreen	more tolerant than other pines
White Pine	easy	white pine blister rust	white pine weevil	can be a sheared hedge; prune candles to shape	sweeping winds can damage	narrowleaf evergreen	will not tolerate air pollution
Scotch Pine	easy; B & B if root pruned	root rot; tip blight; many rusts; nematodes a serious problem	pine tip moth	prune candles to shape; June	varies in needle length and color	leaves last several years	popular Christmas tree
Hemlock	easy; B & B if root pruned	leaf blight; canker rust; needle rust; sapwood rot	scale in eastern states; hemlock borer; bagworms; gypsy moth	reponds well to clipping for low or high mass effect; can be trained to thick hedge	sun scorched when temperature 95°F and above; susceptible to salt injury	NA	NA

There are thousands of different shrubs available for use in the landscape. Therefore, it is necessary to determine the purpose the plant must serve, in order to select the shrub that fulfills the criteria set by the landscaper.

Shrubs are woody plants that are smaller than trees, usually less than 15 feet tall, and they have a multi-stem base. The multi-stemmed base distinguishes shrubs from trees, since trees usually have only a single trunk. An exception is that some shrubs can be trained to have only one stem. These shrubs are called standards and are used for more formal designs.

In previous years, shrubs were used as "foundation plantings", since they provided transition from house to ground by hiding high foundations. Modern houses usually do not have foundations to hide, so shrubs are used for different purposes.

Hedges are shrubs that are usually massed together to form an unbroken line, then trimmed for a more formal look.

Purposes of Shrubs and Hedges

Shrubs - Shrubs serve many purposes in the landscape. They are used as a wall element in the outdoor room. They enclose spaces, helping to create an intimate feeling in yards. They define spaces and act as a transition plant from trees and structures to the ground. Those with ridged and geometric shapes are often used as specimen or accent plants. Softer, less dense shrubs create a soft, silhouetting backdrop for other smaller plants. Shrubs can provide privacy or security by enclosing spaces. To offer full privacy, the shrub should be six feet tall; and its branches should be high, wide, and dense. Shrubs are also used as a screen for blocking unsightly views. Shrubs with spreading, intertwined, and thorny branches are good for helping to direct pedestrian traffic.

Like trees, shrubs can be used as a focal point as well as for seasonal effects. Their texture, color, foliage, stems, flowers, and fruits are important factors to consider for these uses. Like trees, shrubs are also used to soften harsh building lines. Shrubs with fragrant flowers are pleasant near terraces, patios, or under windows of a house or building. Shrubs have the ability to absorb noise and serve as a windbreak. Coarse-textured shrubs do this best. Leaves with hairy surfaces help collect dust and purify the air.

Hedges - A formal hedge can be used as a fence or screen for privacy. It can also serve as a garden border, a boundary, and a means of directing traffic. There are three heights of hedges that serve different purposes. A low hedge, one foot or less, serves as a border for flower beds and walks. A medium hedge, up to six feet, serves as a property border and a backdrop for other plants. A tall hedge, over six feet, helps block wind, sun, and screens unsightly objects or views.

Selection Criteria

The criteria for selecting shrubs is basically the same as for trees, adding a few unique aspects which should also be considered.

Texture - Because shrubs grow to eye level, texture is an important element in selecting them. Fine-textured plants make spaces appear larger, and are a good backdrop for flowers. Coarse-textured plants are better proportioned to large spaces, and they attract more attention than fine-textured plants. Therefore, when using many coarse-textured plants, more fine-textured plants are needed to counterbalance the design.

Size - Since the sizes of shrubs vary so widely, it is important to determine the mature size of the shrub before planting it in the landscape.

Broad- and narrow-leaved evergreens - Care must be taken when using broad-leaved and narrow-leaved evergreens with deciduous shrubs. Broad-leaved evergreens reflect light; making them look lighter in weight than narrow-leaved evergreens, which absorb light; giving them a heavy, dull look. This appearance may not go well with other, light-weight deciduous shrubs. Used in the proper proportions;

these plants together can create a pleasant year-round effect with color, texture, and form.

Deciduous shrubs - Winter stem colors of some shrubs must be considered when selecting a plant. Some turn a red or wine color in winter, which may clash with a landscape's color theme.

Shrub form - There are several basic forms of shrubs. The mature form of a shrub should be considered in selection, since some shrubs look different when young. If chosen when young, they may later grow into something that detracts from the landscape design. Shrubs can be pruned into a desired shape, but this requires high maintenance, another factor to consider when selecting the plant.

Formal or informal - Shrubs can be used in formal or informal landscapes. The type of landscape must be determined before selecting the shrub. Although most can be used in either type of design, some work better in one than the other.

Selection Criteria for Common Shrubs

Specific criteria for the selection of common flowering and evergreen shrubs are found in the tables provided at the end of this lesson.

Summary

Each shrub has unique characteristics that must be considered when selecting it for the landscape. Shrubs and hedges are the plants in the landscape that are used as a transition between trees and structures to the ground. They are usually less than 15 feet tall and have many stems. Hedges are formally pruned shrubs used to help direct traffic or provide a screen. Shrubs are at eye-level so texture is an important factor when selecting them. The mature size of a shrub, its form, and whether it is deciduous or evergreen; should all be points of consideration of selection as well.

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Sunset. New Western Garden Book. Menlo Park, CA: Lane Publishing Co., 1984.

University Extension: University of Missouri-Columbia.

G06830: Selecting Landscape Plants: Deciduous Shrubs

FLOWERING SHRUBS

Berberis thunbergii - Japanese barberry

Cornus sericea - redosier dogwood

Chaenomeles speciosa - flowering quince

Euonymus alatus - winged euonymus or burning bush

Forsythia x intermedia - border forsythia

Ligustrum japonicum - wax leaf privet

Nandina domesticum - nandina or heavenly bamboo

Pyracantha coccinea - scarlet firethorn

Salix gracilistyla - rosegold pussy willow

Spirea vanhouttei - Vanhoutte spirea

Syringa vulgaris - common lilac

Table 2.1 - Flowering Shrub Selection

COMMON NAME	BOTANICAL NAME	HEIGHT	WIDTH	FORM	GROWTH RATE	HARDINESS ZONE	USE IN LANDSCAPE	COLOR (LEAF)
Japanese Barberry	*Berberis thunbergii*	3-6'	4-7'	rounded; dense	medium; space 3' apart	4	hedge; foundation; specimen; mass barrier; shrub border	medium green; reddish in fall
Redosier Dogwood	*Cornus sericea*	7-9'	10'	broad-spreading, multi-stemmed	fast	2	specimen; mass; shrub border	medium green; purplish in fall
Flowering Quince	*Chaenomeles speciosa*	6-10'	6-10'	rounded to irregular	medium; space 4' apart	4	shrub border; specimen; mass; barrier	glossy, dark green; yellow in fall
Winged Euonymus or Burning Bush	*Euonymus alatus*	15-20'	15-20'	upright; flat top; rounded	medium to slow; space 5' apart	3	specimen; naturalistic mass; barrier; hedge; screen	dark green; brilliant red in fall
Border Forsythia	*Forsythia x intermedia*	6-10'	10-12'	rounded with arching branches	medium to fast; space 4' apart	5	specimen; border; mass; screen;	mdeium green; bronze in fall
Wax Leaf Privet	*Liqustrum japonicum*	6-10'	6-8'	rounded; upright to spreading;	fast; space 5' apart	7-10	residential and large scale; screen; border; hedge	glossy, dark green
Nandina or Heavenly Bamboo	*Nandina domestica*	4-5'	2-3'	upright; irregular	medium to fast; space 2' apart	6-10	specimen; containers; mass	medium green; bright red in fall
Scarlet Firethorn	*Pyracantha coccinea*	6-15'	10'	upright; rounded; irregular	fast; space 8' apart	6	specimen; barrier; screen; hedge	glossy, dark-green
Rosegold Pussy Willow	*Salix gracilistyla*	6-10'	5-8'	rounded	extremely fast	5	specimen; barrier; screen	bluish-gray
Vanhoutte Spirea	*Spirea vanhouttei*	5-8'	5-8'	rounded with pendulous branches	fast; space 4' apart	5	shrub border; foundation	pale bluish-green upperside; lighter underside; bronze-yellow in fall
Common Lilac	*Syringa vulgaris*	8-10'	6-12'	upright; irregular; multi-stemmed; leggy	medium; space 8' apart	3	shrub border; massing	dark green; no fall color

Table 2.1 - Flowering Shrub Selection continued

FLOWERING COLOR, LENGTH OF BLOOM	FRUITING TIME/TYPE	TEXTURE	SOIL CONDITIONS	WATER REQUIREMENTS	FERTILIZING REQUIREMENTS	LIGHT REQUIREMENTS	TEMPERATURE REQUIREMENTS
not showy; small yellow flowers in early spring	red berries in October that persist into winter	fine to medium	wide range; well-drained; acidic to alkaline	moist to dry; withstands drought	medium	sun to part shade; best in full sun	to zone
white 1 1/2 to 2 1/2" flowers in late May to June	white 1/5" berry-like fruits in September	medium	wide range	moist to wet	medium	sun	to zone
[illegible] white, or pink flowers in early spring (March)	yellowish-green pomp in late summer	medium	wide range; well-drained	medium	medium; chlorosis in alkaline soils	sun to part shade	to zone
not important	4-lobed capsule; red to orange	medium	wide range; acidic to alkaline; well-drained	medium to dry	medium to low	sun to part shade	to zone
bright yellow flowers in early spring that last 2-3 weeks	not important	medium	wide range; well-drained; acidic to alkaline	low to medium	medium	sun to part shade; best in full sun	to zone
white 4-6" fragrant, showy clusters in June and July	black clusters in fall and winter	medium to coarse	wide range; acidic to alkaline; medium drainage	medium; drought resistant	medium	sun to part shade	to zone; severe winters will kill twigs
showy white panicles in mid-summer	red cluster in fall and winter	fine	wide range; loam; pH 5.0-6.5; chlorosis in alkaline soils	drought resistant	low	sun to part shade	heat resistant; dies back at 0°, loses leaves at 10°
showy white clusters in June	bright orange-red clusters that persist into winter	medium	wide range; well-drained, acidic to alkaline	medium to dry	medium	sun to part shade; better flowers in full sun	to zone
showy; 1 1/4" long; pinkish-reddish tinged catkins	capsule that contains cottony or silky, hairy seeds	fine	well-drained; deep, not chalky soil	moist	medium to low	sun	to zone
white showy flowers in late spring	not important	medium to fine	wide range, pH 6.0-7.0	medium	medium	sun to part shade	to zone
white, pink, purple, or blue fragrant flowers in late spring	not important	medium to coarse	wide range; neutral pH	medium to low	medium to low	sun	to zone

Table 2.1 - Flowering Shrub Selection continued

COMMON NAME	TRANSPLANT-ABILITY	DISEASE PROBLEMS	INSECT PROBLEMS	PRUNING METHOD AND TIME	LIFE SPAN	SPECIAL CONSIDERATIONS	OTHER COMMENTS
Japanese Barberry	easy; bare root	bacterial leaf spot; anthracnose; root rots; wilt	barberry aphid; scale	anytime	medium	many thorns; good fall color	some clutivars have purple foliage; collects trash
Redosier Dogwood	easy; bare root or B & B	stem canker	scales; bagworms	to keep yellow color prune old wood	medium	good fall color; attractive red stem in winter	spreads by underground stolons
Flowering Quince	easy; B & B	leaf spot	scale; aphids	prune to 6" aboveground after spring bloom or annually; thin stems after blooming	medium	only showy 2 weeks of year in spring; thorny; collects trash	fruit good for jellies; thornless varieties available
Winged Euonomous or Burning Bush	easy; B & B	none serious	none serious	withstands pruning	long	sensitive to salt; excellent fall color in sun	compact varieties (5') are the common plants in nurseries
Border Forsythia	easy; bare root or B & B	crown gall; leaf spots; forsythia stem gall	spider mites	prune after flowering; remove older stems	medium	late frosts can kill blooms; not for foundation planting	attractive arching branch pattern in winter; overused
Wax Leaf Privet	easy; B & B	none serious	none serious	after flowering	medium	showy, fragrant flowers	wildlife food
Nandina Heavenly Bamboo	easy	none serious	none serious	after flowering	medium	plant in groups for cross pollination; protect from southwest winds	wildlife food
Scarlet Firethorn	difficult; container; in spring	fireblight; scab on fruit; twig blight; root rot	scale; lace bug; aphids	needed to keep in bounds; any time	long	fruit produced on 2-year wood; fruit has nice character	wildlife food; thorns
Rosegold Pussy Willow	easy; container or B & B	bacterial twig blight; crown gall; leaf blight; powdery mildew; rust; scabs	lace bug; aphid; willow flea; weevil borer; scale	summer or fall	long	showy male flowers	
Vanhoutte Spirea	easy	none serious	aphids	should not be sheared; best to prune to base; prune after flowering	long	very showy flowers	good shrub border plant
Common Lilac	easy	powdery mildew; bacterial blight	borer; scale	needs constant grooming annually after blooming; remove 1/3 of oldest canes	long	fragrant flowers	best for cool climates; renew old overgrown plants; sensitive to air pollution

EVERGREEN SHRUBS

Buxus microphylla - Korean boxwood littleleaf boxwood

Euonymus kiautschovicus - spreading euonymus

Ilex crenata "Helleri" - Japanese holly

Juniperus chinensis "Hetzii" - hetzii juniper

Juniperus chinensis "Phitzeriana" - phitzer juniper

Mahonia aquifolium - Oregon grape holly

Pinus mugo - mugo pine

Rhododendron catawbiense - catawba rhododendron

Taxus cuspidata - Japanese yew

Thuja occidentalis - Eastern or American arborvitae or white cedar

Viburnum rhytidophullum - leatherleaf viburnum

Table 2.2 - Evergreen Shrub Selection

COMMON NAME	BOTANICAL NAME	HEIGHT	WIDTH	FORM	GROWTH RATE	HARDINES ZONE	USE IN LANDSCAPE	COLOR (LEAF)
Korean Boxwood or Littleleaf Boxwood	*Buxus microphylla*	3-4'	3-4'	compact; rounded	moderate to slow; space 2' apart	5; hardiest of species	specimen; hedge; mass grouping; container; foundation; border;	green, yellow to brownish-green in winter
Spreading Euonymus	*Euonymus kiautschovica*	6-8'	8-10'	broadly oval	fast; space 6' apart	5	natualistic; espalier; screens, informal hedge, massing	green; rusty-green in winter
Japanese Holly	*Ilex crenata "Helleri"*	2-4'	3-4'	compact; dense; rounded	slow; space 2' apart	5	containers (will trail over); hedge; foundation; patio; border	dark green
Hetzii Juniper	*Juniperous chinensis "Hetzii"*	15'	15'	upright; spreading	fast; space 5' apart	4-10	screen; foundation; dry, windswept slope; mass; specimen	blue-green
Pfitzer Juniper	*Juniperus chinensis "Pfitzeriana"*	6'	6-8'	wide-spreading;	medium to fast; space 5' apart	4	specimen; mass; screen; hedge	gray-green; needle-like
Oregon Grape Holly	*Mahonia aquifolium*	3-9'	3-5'	upright; irregular	slow--2' to 3' over 3 to 4 years	5	shrub border; foundation; specimen	dark green; holly-like, purplish-bronze in fall
Mugo Pine	*Pinus mugo*	10-20'; "compacta" 4 to 5'	25-30'; "compacta" 4 to 5'	mounded	slow; space 4' apart	2	accent; specimen; rock gardens; residential scale; mass; foundations	medium green needles; 2 in a bundle
Catawba Rhododendron	*Rhododrendron catawbiense*	6-10'	6-8'	rounded	slow to medium; space 4' apart	4	mass; specimen; under-story; woodland area	dark green; yellow-green underside
Japanese Yew	*Taxus cuspidata*	4-6'	5-7'	broad oval; compact; irregular	slow; space 4' apart	4	foundation; hedge; screen border; mass	dark green; yellowish underside
Eastern or American Arborvitae or White Cedar	*Thuja occidentalis*	40-60'	10-15'	pyramidal	slow to medium	2	hedge; screen; windbreak;	dark green; brownish yellow in winter
Leatherleaf Viburnum	*Viburnum rhytidophyllum*	8-10'	6-8'	upright; oval to round; loosely branched	medium; space 5' apart	6	specimen; shrub border; accent	dark green; light to white under-side; leathery

Table 2.2 - Evergreen Shrub Selection continued

FLOWERING COLOR, LENGTH OF BLOOM	FRUITING TIME/TYPE	TEXTURE	SOIL CONDITIONS	WATER REQUIREMENTS	FERTILIZING REQUIREMENTS	LIGHT REQUIREMENTS	TEMPERATURE REQUIREMENTS
fragrant terminal clusters; not important	capsule	fine	well-drained; high organic matter; best in slightly acidic soils	medium	medium	sun to part shade	protect from drying winds and extreme low temperature
showy, small, greenish-white clusters in August	pale green; orange in fall and winter; showy; November	medium to coarse	wide range; acidic to alkaline; fertile to poor	medium	medium	sun to part shade	may die back in winter with cold temperature
not important	1/4" black berry-like fruit in September	fine	medium drainage; pH 5.0-6.0; loam	medium	high each year	sun to part shade, part shade if poor soil	to zone
not important	bluish-gray; fall and winter; colorful	fine	wide range; well-drained; prefers alkaline, though tolerates acid	medium, does well in dry areas	medium	full sun, will grow in part shade	to zone
not important	small cones	fine	wide range; alkaline; tolerates acid; well-drained; good for rocky soils	medium	medium	sun to part shade	to zone
bright yellow flowers in late April; slightly fragrant	grape-like true berry; blue-black with 1/3" bloom on surface; August to September	medium	acidic; well-drained	moist	medium	shade	not in hot sun or wind
not important	cones; not important	medium	wide range; prefers deep, moist, loam	medium	medium	sun to part shade	to zone
rosy-lilac to magenta-purple and white in early summer; very showy	capsule	bold-coarse	well-drained; organic acid soil	medium to high	medium	best in part shade	to zone
not important	red-coated on female only	medium to fine	well-drained; acidic to alkaline soil	medium to high	medium	sun to shade	to zone
not important	1/3 to 1/2" long; yellowish cones	medium-fine	well-drained; marshy; loam; tolerates alkaline soil	high humidity; medium to moist	medium	sun	to zone
creamy-white terminal cluster 4"-8" across in late spring	not important	coarse	medium drainage; acidic to alkaline	medium	fertilize each year	shade to part shade	to zone

Table 2.2 - Evergreen Shrub Selection continued

COMMON NAME	TRANSPLANT-ABILITY	DISEASE PROBLEMS	INSECT PROBLEMS	PRUNING METHOD AND TIME	LIFE SPAN	SPECIAL CONSIDERATIONS	OTHER COMMENTS
Korean Boxwood or Littleleaf Boxwood	easy; B & B or container	canker; blight; leaf spot; root rot	mealy bugs; boxwood leaf miner; giant hornet; boxwood webworm	prune to remove dead twigs	long	don't cultivate around as roots are close to surface	hardier than common boxwood; broadleaf evergreen
Spreading Euonymus	easy	mildew; anthracnose; crown gall; leaf spot	aphids; thrips; scale	some varieties may be tree form if pruned	long	flowers attract flies; not good for patio	leaves droop in winter
Japanese Holly	easy	none serious	none serious	can be sheared into formal shapes	medium	attractive light reflective ability	a hardier variety
Hetzii Juniper	easy	phomopsis twig blight	bagworms	anytime	long	not applicable	not applicable
Pfitzer Juniper	easily; B & B or container	phomopsis blight	bag worms; juniper scale; mites; aphids	specimens may be pruned to tree forms	long	sometimes found to grow taller than listed	good landscaping cultivars are available
Oregon Grape Holly	medium	leaf rust; leaf spot; leaf scorch	barberry aphid; scale; whitefly	annually, just after flowering	medium	good yellow flowers and grape-like fruit	unsweeping winds and winter sun cause leaf scorch
Mugo Pine	easy; B & B if root pruned	rusts; wood rots	borer; scale	prune annually to keep dwarf	long	slow growing	confusing due to variety of sizes; compact varieties used most often
Catawba Rhododendron	B & B or container	botrytis blotch; blights; gray blight; canker; crown rot; powdery mildew	leaf hopper; whiteflies; mealybugs; borer; scales thrips	after flowering	long life if in good conditions	protect from winter sun and wind; mulch at all times;	must have good conditions
Japanese Yew	easy; B & B	none serious	none serious	anytime	long	tolerates city conditions	hardiest yew; lots of good varieties
Eastern or American Arborvitae or White Cedar	easy	leaf blight; tip blight; juniper blight; cedar tree canker; leaf browning and shreding	bagworm; arborvitae aphid; leaf miner; mites; mealybug; scale	tolerant; prior to growth in spring	long	high winds, snow, and ice can damage; has tansy-odor when bruised	other varieties turn ugly yellow-brown in winter
Leatherleaf Viburnum	easy; B & B	none serious	none serious	prune after flowering	long	hardiest of evergreen viburnums	best with protection from sun and wind

Ground covers are often referred to as "problem-solvers". They are versatile plants that are able to be used where others will not work.

Purposes of Ground Covers

Definition - Ground covers are low-growing plants (usually less than 18" tall) that cover the ground rapidly by a dense, trailing, growth habit. Many times they are used instead of turf. Ground covers can be needle or broad-leafed evergreen, or deciduous. They can be herbaceous or woody. Some will flower; some will not. Usually ground covers are used to lower maintenance, although sometimes the opposite occurs.

Uses - Ground covers are good for problem areas. These include steep slopes; shady or sunny areas; and soils which are too wet, dry, acidic, or alkaline. Ground covers are often found along highway banks or around trees in yards where mowing is difficult and dangerous. Soil erosion can easily be controlled by planting a ground cover to absorb rainfall and cut down on surface run-off. In areas of a landscape that are too narrow or small for turf or other plants to be maintained, ground covers are a good alternative. They also hide litter from messy trees and fill in small spaces around paths and stepping stones in a garden. Some ground covers will withstand foot traffic and some will not. In wide open areas, they help reduce glare and shade the soil to keep it from drying out rapidly. Ground covers also work well in protecting the roots of shallow-rooted trees or shrubs. In hard-to-maintain areas, ground covers help prevent weeds. Some ground covers do not require as much water or nutrients as grass, so they are in less competition with trees and shrubs.

Aesthetic benefits - In a landscape planting of several trees and shrubs, a ground cover is effectively used to blend the plants with the enviroment. They offer a variety of colors, textures, and patterns that work well as a transition from turf grasses to other plants or objects. Ground covers should not only be used as problem-solvers. They offer much ornamental value to a landscape as well as help create harmony and tranquility in the design.

Selecting Ground Covers

Site - When selecting a ground cover for the landscape, determine the condition of the site to be planted. Whether the location is sunny or shady, wet or dry, acidic or alkaline; there is a ground cover for every situation. The landscaper must match the cultural requirements of the plant to the growing enviroment.

Growth habit - Ground covers come in three basic types: vining, creeping (underground stolon), and prostrate. Landscapers can choose one with the growth habit that will best suit their needs. The height and the intended use must be considered, but width is not important. The growth habit; mature size; and light, water, and temperature requirements; must all be known before the ground cover is planted. It is also helpful to know the best planting time. Some ground covers are more sensitive than others; making the time of least environmental stress best for planting. In cold winter areas like Missouri, ground covers are subject to "heaving." When the ground freezes and thaws repeatedly, it causes the plants to be pushed out of the ground, exposing their root systems, and killing them. When planting, allow time for them to become established before winter. With careful selection, ground covers can bring a very pleasant look to any landscape, while filling a specific function.

Purposes of Vines

Definition - Vines are much like ground covers. Both have a trailing form of growth. Some plants can be used as both. A vine is a climbing plant. It grows against gravity only if it can attach itself to a vertical support or surface; otherwise, it will trail along the ground.

Uses - Vines have curvelinear patterns of line, texture, and color. They are very decorative, and some are very fragrant. They also serve many purposes, allowing versatility in their use. They provide more show and interest from less ground space, and are more flexible in tight spaces than any other plant form. Vines can be used as screens for privacy and shade. They also reduce glare and heat. They can be used on fences or trellises to add seasonal effects such as flowers, fruit, leaves, and branching patterns. They can be used to hide old tree stumps, utility poles, and dead trees. They can decorate rock walls or naturally-occurring rock outcrops.

Evergreen vines offer year-round foliage, whereas deciduous vines offer beautiful irregular stem patterns on bare walls or surfaces. Sometimes these branching patterns are more beautiful than the leaves. They are good to use on a southern exposure where they provide cooling insulation in the summer and allow the sun to filter through in the winter.

Aesthetic benefits - Vines can soften fences, walls, and harsh architectural lines of buildings; however, they should be carefully chosen, because a poorly chosen vine might hide good architecture. Vines create the sense of having a ceiling in an outdoor room, bringing the landscape down to human scale. A vine can be pruned to keep all side branches and leaves off the main "trunk" until it reaches the desired height; then it grows out to form a ceiling, or arbor, of foliage.

Selecting Vines

Method of climbing - In order to select a vine, landscapers must first know the soil and climate requirements of the vine. Next, they must know the vine's method of climbing. There are three methods: twining or winding of the stems around the support; tendrils, which are thin flexible shoots that wrap themselves around anything they contact; or clinging. A vine clings to the surface in two ways. One, is by tendrils with disk-like adhesive tips or "suction-cups," which attach themselves firmly to any surface, including glass. The other, is by small aerial rootlets that grow out from the stem and "dig" themselves into any crevice of a rough-textured surface. Clinging vines are best used on stone or masonry, not wood. Their tight clinging may hold moisture close to wood surfaces, causing them to rot. Once the method of climbing is known, the proper vine and support structure can be selected. If the vine is needed for a particular problem area, both may need to be selected.

Growth - The rate of growth and the mature size (height and width) of the vine should be known before choosing, so it will not outgrow the chosen location.

Other features - The texture, density, and color should also be considered in the selection process. The seasonal decorative features; such as flowers, fruit, fall color, and winter patterns should also be considered.

Selection Criteria

Table 3.1, included at the end of this lesson, lists the criteria to aid in the selection of ground covers and vines in the landscape.

Summary

Ground covers and vines can be used in areas of the landscape where other plants may not be successful. Selection of vines and ground covers should be made according to the purposes desired, and their ability to adapt to the requirements of the area. Vines and ground covers are often a beautiful addition to the landscape.

Credits

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GROUND COVERS AND VINES

Ajuga reptans - ajuga or bugleweed

Celastrus scandens - American bittersweet

Coronilla varis - crown vetch

Euonymus fortunei radicans - bigleaf wintercreeper

Hedra helix - English ivy

Juniperus horizontalis - creeping juniper

Lonicera japonica Halliana' - Hall's honeysuckle

Vinca minor - creeping myrtle or periwinkle

Table 3.1 - Ground Cover and Vine Selection

COMMON NAME	BOTANICAL NAME	HEIGHT	WIDTH	FORM	GROWTH RATE	HARDINESS ZONE	USE IN LANDSCAPE	COLOR (LEAF)
Ajuga or Bugleweed	*Ajuga reptans*	3-6"	spreading	mat-like clump	fast; may be invasive	3	ground cover: rock garden, edging, border	shiny green, burgundy
American Bittersweet	*Celastrus scandens*	20'	15-20'-variable, space 12" apart	spreading	fast	3	Vine: screen with support from walls, trellises, or arbors	bright yellow in fall
Crown Vetch	*Coronilla varis*	9-18"	20"; space 24" apart	sprawling, spreading	fast	4	ground cover: steep banks, rock garden, highway erosion control; too coarse for most gardens	gray-green
Bigleaf wintercreeper	*Euonymus fortunei "Radicans"*	6-7' vine; 12-24" ground cover	variable	irregular spreading	medium to fast	4	ground cover or shrub vine; will grow as vine with support	dark green
English Ivy	*Hedra helix*	6-10" as ground cover	variable; space 12" apart	spreading	fast	6	vine: trellis cover; ground cover: planter box, lawn substitute; deep roots good for erosion control	mature--deep green upperside, yellow-green underside; young--light green
Creeping Juniper	*Juniperus horizontalis*	12-16"	10'; space 8' apart	irregular spreading	moderate	2	ground cover: rock gardens; hangs over a wall	blue-green; greenish-purple in winter
Hall's Honeysuckle	*Lonicera japonica "Halliana"*	as ground cover 6" mound	20-30'; space 6-10' apart	spreading	fast	3	vine: to cover bank or fence when controlled	dark green
Creeping Myrtle or Periwinkle	*Vinca minor*	10"	moderate spread; space 12" apart	mat-forming	moderate	5	ground cover: rock garden, tub, hanging basket	blue-green

Table 3.1 - Ground Cover and Vine Selection continued

FLOWERING COLOR; LENGTH OF BLOOM	FRUITING TIME/TYPE	TEXTURE	SOIL CONDITIONS	WATER REQUIREMENTS	FERTILIZING REQUIREMENTS	LIGHT REQUIREMENTS	TERMPERATURE REQUIREMENTS
April to May; violet-blue to purple	not important	medium	tolerates poor soil; well-drained	medium	low to medium	shade--where grass will not grow; also part sun	to zone
inconspicuous	yellow and orange through winter	medium to coarse	any soil	medium	medium to low	sun to part shade; best fruiting in full sun	to zone
pink-purple in summer	not important	fine to medium	tolerates poor soils; well-drained, dry soils	low	low	full sun	to zone
not showy	many bright orange fruit through winter	medium	wide range of soil	moderately drought resistant	responds well to fertilizer	full sun to part shade	not hot, western exposure
inconspicuous, globe-shaped	not important	medium to coarse	wide range; fertile, moist, well-drained	moist	medium to high	grows well in shade; will take sun	to zone
inconspicuous	blue on a short stem, sometimes glaucous	fine	wide range of soils; grows well in sandy, rocky soils	moderately dry to dry	medium to low	sun; susceptible to fungus in shade	to zone
white, fragrant 2" flowers that yellow with age	black, fleshy berry	coarse	most any soil	drought-tolerant	medium	sun or light shade	to 20°F
bright blue (white and purple cultivars available); not showy	none	fine to medium	tolerates most soils	moderately tolerant of drought	medium	best in part shade or shade, but tolerates full sun	does not tolerate hot temperatures

Table 3.1 - Ground Cover and Vine Selection continued

COMMON NAME	TRANSPLANT-ABILITY	DISEASE PROBLEMS	INSECT PROBLEMS	PRUNING METHOD AND TIME	LIFE SPAN	SPECIAL CONSIDERATIONS	OTHER COMMENTS
Ajuqa Bugleweed	easy by division	crown rot from overcrowding or poor aeration	none serious	division	long		can remove flower stalks with a lawn mower set at a high setting
American Bittersweet	easy	none serious	Euonymus scale	heavy pruning required in late winter or spring to keep in bounds	long		need male and female to flower and fruit; 1 male per 6 female
Crown Vetch	by seed; 1 pound/1,000 sq. ft.	none serious	none serious	mow to 6", 2-3 times a year		legume-nitrogen fixer	
Big leaf wintercreeper	easy	mildew in shady, calm locations	Euonymus scale, stem gall, nematodes	clip back as needed	long		easy to grow
English Ivy	easy	bacterial leaf spot	spider mites	trim back when necessary and to enhance compact growth	long		
Creeping Juniper	easy	juniper blight	spider mites	trim back when necessary	long		
Halls Honeysuckle	easy	none serious	none serious	cut back heavily to keep in bounds	long	can be invasive; very vigorous	must keep in bounds, use as either vine or ground cover
Myrtle or Periwinkle	easy	none serious	none serious	shear annually to form dense growth	long		roots develop at nodes with contact with soil

Flowers come in a wide variety of colors and fragrances. They are an important element of landscape design. They create a vivid display wherever they are planted. Their brilliant colors easily make them the focal point of the design. This can interfere if they are not supposed to be the focal point. In addition, they can detract from the important objects in the design. For this reason, flowers must be chosen with care.

Flower Groups

There are three groups of flowers: annuals, perennials (including bulbous perennials), and biennials. Annuals are plants whose life cycle is completed in one growing season. Their advantage is that they bloom for several months producing lasting, seasonal color.

Annuals - There are two types of annuals: hardy and tender. Hardy annuals can tolerate cool temperatures, even frost. They can be seeded outdoors in the early spring or the preceding fall. Tender annuals should be started indoors and transplanted outdoors when danger of frost is past. Some can be seeded directly outdoors in the spring, after the soil has warmed.

Perennials - Perennials are plants that live from year to year, having one period of blooming per season. Most die back to the roots in winter, and grow again in the spring or when the time is right for each plant. Some perennials are grown only for their foliage, and the flowers detract from the plant. Others are grown only for their flowers. Perennials offer many years of satisfaction; while saving the time, labor, and expense of planting each year. They also form the framework in the garden around which annuals and biennials can be planted. Perennials are not entirely permanent; they can be dug up and moved if the gardener wishes.

Bulbous perennials are those plants that grow from tubers, corms, rhizomes, tuberous roots, or true bulbs; and bloom once a year. These include two categories; hardy bulbs and tender bulbs. Hardy bulbs are those able to survive the winter outside in the ground. Examples are; hyacinths, daffodils, and tulips. Tender bulbs cannot survive the winter and have to be dug up each fall, stored in warmer temperatures for the winter, and set out again in the spring. Examples are; gladiolus, canna, caladium, and tuberous begonia.

Biennials - Biennials are plants that complete their life cycle in two years. The first year, they have vegetative growth; the second year they flower and then die. These include; English daisy and foxglove.

Purposes

Beds and borders - Flowers have many uses in the landscape. Two popular uses for flowers, are flower beds and borders. A flower bed is a free-standing, cultivated area planted with only flowers; surrounded by the lawn or open area to allow viewing from all sides. They have no woody plants as a backdrop. Flower beds can be difficult to design. Beds are used as a focal point in landscape when they neither conflict with other objects, nor invite damage from activities. Flower beds should not be used in the public area of a house since they detract from the entry.

A flower border is a design placed in front of a backdrop of plants or the edge of a house, sidewalk, or fence. A border is accessible and viewed from only one side. Borders should be no more than five feet deep so they can be maintained from the back without damaging plants in the front. Borders are easier to design than beds and are used to soften the edges of buildings, sidewalks, fences, and lawns.

Other uses - Flowers are used in several other ways such as; in containers, rock gardens, mass plantings, edgings, ground covers, hanging baskets, rock walls, backgrounds, house plants, specimens, carpet and pattern beds; as well as in arrangements of cut or dried flowers.

Flower Selection

Site conditions - When selecting flowers, several factors about the existing site must be considered. These include: cultural requirements, the amount of light and moisture available, the type of soil, and the temperature. These must be determined; and then plants that match these conditions can be planted. The soil may need amendments before any plants will grow.

Design decisions - Design decisions; such as whether to use a bed or a border, an informal or formal garden, and the color scheme; must be determined first.

Other characteristics - Characteristics of the plant; such as height, color, spread or width, form, texture, blooming season, and length of blooming time; must all be considered before selecting a plant.

While annuals bloom continuously during the summer, perennials bloom at different times and for different lengths of time. Many beds and borders are designed so that something is in bloom all during the summer, allowing different points of interest each week or two. Some beds and borders are timed to be spectacular for one or two weeks during the season.

Perennial Characteristics

Table 4.1, on the following pages, contains common perennials used in the landscape. This is only a very small sample of the hundreds of perennials available for landscape use. These characteristics will help in selecting perennials for a particular design. Without knowing plant characteristics before selecting, a design could look like a chaotic mess instead of a beautiful, flowing landscape.

Summary

With the variety of color, texture, and seasonal interest flowers provide; they should be used often but selected with care. Knowledge of characteristics in selecting flowers helps landscapers to use them successfully in a landscape plan.

Credits

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PERENNIALS

Artemisia schmidtiana - silver mound

Astilbe x ardendsii - false spirea astilbe

Aquilegia hybrids - columbine

Chrysanthemum x morifolium - garden mum

Coreopsis lanceolata - coreopsis

Hemerocallis hybrids - day lily

Heuchera sanquinea - coral bells

Hosta species - plantain lily or hosta

Liriope spicata - creeping lily turf

Phlox subulata - creeping phlox

Table 4.1 - Perennial Selection

COMMON NAME	BOTANICAL NAME	HEIGHT	WIDTH	FORM	GROWTH RATE	HARDINESS ZONE	USE IN LANDSCAPE	COLOR (LEAF)
Silver Mound	*Artemisia Schmidtiana*	4-6"	12"; space 8" apart	round mound	medium-slow	4	perennial border; specimen; rock garden; border	silvery-white
False Spirea Astilbe	*Astilbe x ardendsii*	4'	2'; space 2' apart	erect	medium-fast	5	border; wild gardens; water areas	green
Columbine	*Aquilegia hybrids*	2-3'	1'; space 9" apart	rounded erect stems	fast	4	naturalized settings; rock gardens; border	deep green
Garden Mum	*Chrysanthemum x morifolium*	1-3'	2 1/2'; space 12-18" apart	columnar to round mound	fast	5	border; mass plantings; late flower display	green to grayish-green
Coreopsis	*Coreopsis lanceolata*	2'	space 12" apart	upright, sprawling	fast	3	front or middle of border	dark green
Day Lily	*Hemerocallis hybrids*	depends on variety--20" to 3-4'	2'; space 18-36" apart	rounded upright	medium	4	mass planting; border	bright green
Coral Bells	*Heuchera sanguinea*	flower stalk--2', 10-12" tall	space 12" apart	round clump w/stalked flowers	medium-slow	4	for small areas; an edging or open border	dark, bright green
Plantain Lily or Hosta	*Hosta species*	2 1/2' tall	40"; space 30-36" apart	rounded mound	medium	3	border	bluish-green
Creeping Lily Turf	*Liriope spicata*	8-12" tall; flower scapes 10" tall	12" and spreading; space 12" apart	mound w/arching leaves	fast	4	ground cover; edging; rock garden	dark green; pale green in winter
Creeping Phlox	*Phlox subulata*	3-6"	2'; space 12-18" apart	prostrate mound; dense	fast	4	edging; walls; ground cover	bright green

Table 4.1 - Perennial Selection continued

FLOWERING COLOR; LENGTH OF BLOOM	TEXTURE	SOIL CONDITIONS	WATER REQUIREMENTS	FERTILIZING REQUIREMENTS	LIGHT REQUIREMENTS	TEMPERATURE REQUIREMENTS
small, white, or yellow flowers; not showy	fine	tolerates poor, sandy soil; well-drained	low; will rot in wet soils	low	full sun	hot
red, pink, white, or lavender spike-like flowers in June to July	medium	well-drained, fertile, moist	summer--dry; winter--dry	medium-high; fertilize each spring	full sun or partial shade	to zone
red, pink, yellow, blue, white, or purple flowers from May to June	medium-coarse	excellent drainage; sandy-loam soil	medium-high	medium	full sun; partial shade lengthens flowering season	to zone
yellow, orange, red, bronze, white, or lavender flowers from August to frost	medium-coarse	prefers well-drained, moist soil; well-drained soil essential for winter survival	high	heavy	full sun	to zone
bright yellow flowers from June to September	medium	well-drained; ordinary garden soil	medium	medium	full sun	to zone
many colors; 3-4 weeks at different times depending on variety; some are repeat bloomers	fine	well-drained, high inorganic matter, medium fertility moist soil	medium	medium	prefer sun, but will grown in partial shade	to zone
bell-shaped; red, coral, or pink 1/2" wide flowers on 2' stalks from June to September	coarse	well-drained, moist soil with high organic matter	medium-high	low	part shade is best	keep out of hot afternoon sun
white to pale lilac flowers in July	coarse	well-drained , moist; high in organic matter; no soggy soil	moist, not wet	low-medium	partial or deep shade	to zone
1/4" wide, pale violet to white flowers on stalks; 8-10"; summer	fine	well-drained, moist; fertilie soil with organic matter added	moist	medium	partial shade to shade	to zone
red-purple, violet-purple, pink, and white flowers from March through May	fine	well-drained, gritty soils; alkaline	low-medium	medium-low	sunny or partial shade	to zone

Table 4.1 - Perennial Selection continued

COMMON NAME	TRANSPLANT-ABILITY	DISEASE PROBLEMS	INSECT PROBLEMS	PRUNING METHOD AND TIME	LIFE SPAN	SPECIAL CONSID-ERATIONS	OTHER COMMENTS
Silver Mound	easy by root division	rust	none serious	prune foliage before flowering to keep plant from falling open in the middle	long	does not tolerate much winter moisture because of silvery coating on the leaves	
False Spirea Astilbe	easy	powdery mildew; wilt	Japanese beetles; spider mites	divide every 3 years	long		
Columbine	easy; divide in spring	leaf spot; crown rot; root rot; rust	leaf miner; columbine borer; aphids	none required	usually acts as annual	should be planted where fading leaves can be camouflaged by other foliage	can be used as cut flowers
Garden Mum	easy	bacterial blight; leaf spot; wilt; rust; powdery mildew; aster yellows	aphids; stalk borers; leaf miner; spider mites	can prune back early summer to maintain height; stop pinching in mid-summer or when flowering begins	long	shallow rooting causes need for regular watering; apply a light winter mulch	can be used as cut flowers; many cultivars available
Coreopsis	easy	leaf spot, rust, powdery mildew	chewing insects	remove faded flowers before they seed	long	not invasive like other varieties	
Day Lily	easy	none serious	none serious	divide most vigorous varieties every 3 years	long	individual blossoms last one day, but bloom over a long season	
Coral Bells	easy	none serious	none serious	divide when woody; remove faded blooms	long	drainage important in winter	
Plantain Lily or Hosta	easy	none serious	snails, slugs, and other chewing insects	remove faded blooming stalks	long	divide clumps as needed in spring or fall	wet soil in the winter can damage these plants
Creeping Lily Turf	easy	none serious	none serious	can mow over the top in early spring to remove old foliage; set mower blade high	long	foliage may be unattractive in winter north of zone 6	remove old foliage in spring to promote new growth
Creeping Phlox	easy	rust	spider mites	mow halfway to ground after flowering to form dense plant	long	evergreen	

A well-manicured lawn, along with well-groomed trees and shrubs, adds to the appearance and value of a house or business.

Purposes

For the purpose of landscaping, turfgrasses are the lowest growing and have the finest texture of available plants. They provide a low, level foreground on which to plant other materials.

Turfgrasses provide an appealing and inviting carpet of green around a home. They help unify the tree and flower plantings in the yard, as well as provide a play or work area. Turfgrasses help control erosion by absorbing rainwater instead of allowing it to run off, carrying precious top soil with it. Turfgrasses help reduce heat from the sun, making an area cooler and more comfortable for sitting or walking. They also reduce the sun's glare.

Turfgrass Selection Considerations

Desired use of a lawn must be determined before selecting a variety of turfgrass to use. The climate must also be considered. Temperature and moisture are the most limiting factors in turfgrass consideration. Temperature is the leading factor, since water may be somewhat controlled by irrigation. It must be determined if the grass will grow in sun, shade, or both. One must know whether there are slopes steeper than three to one (one foot high for each three feet horizontally), because grasses are hard to establish and maintain on slopes greater than this. One must also know if the soil is well-drained and what the pH is.

When selecting a turfgrass species the following characteristics must be considered to see if the species fits one's needs.

1. Hardiness zone
2. Temperature requirements: warm-season, 80°-95°F daytime; cool-season, 60°-70°F daytime
3. Drought-tolerant or high water requirements
4. Annual or perennial
5. Light exposure: sun, shade, or both
6. Wear tolerance; durability
7. Habit of growth; creeping, bunching
8. Planting method and establishment time
9. Rate of growth
10. Fertilizer requirements; heavy or light feeders
11. High or low maintenance
12. Resistance to pests and diseases
13. Mowing height
14. Mature natural height
15. Used as mixture or single species

Turfgrass Characteristics

Selection characteristics of six common turgrasses grown in Missouri are located on Table 5.1 at the end of this lesson. These characteristics must be known before a grass can be selected for a specific location.

Summary

Turfgrasses are used to create appealing lawns that serve to unify tree and flower plantings around a home. Turfgrasses are also used for parks, commercial sites, and athletic fields. The existing conditions on a site, as well as characteristics of an individual turfgrass, must be known in order to select a successful turfgrass for a growing site.

Credits

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Ingles, Jack E. Ornamental Horticulture Principles and Practices. 1st ed. Albany, NY: Delmar Publishers Co., 1985.

Kucera, Clair K. The Grasses in Missouri. University of Missouri-Columbia, 1961.

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TURFGRASSES

Cynodon dactylon - Bermudagrass

Festuca arundinacea - tall fescue

Festuca rubra - red fescue

Lolium perenne - perennial ryegrass

Poa pratensis - Kentucky bluegrass

Zoyzia japonica - zoysia grass

Table 6.1 - Turfgrass Selection

COMMON NAME	BOTANICAL NAME	HARDINESS ZONE	SEASON WARM/COOL	ANNUAL/ PERENNIAL	GROWTH HABIT	NATURAL HEIGHT	MOWING HEIGHT	SOIL TOLERANCE	FERTILIZING REQUIREMENTS
Bermuda Grass	*Cynodon dactylon*	7	warm	perennial	stolon, rhizome, creeping	12"	1-2"	rich, moist, pH 5.2-7.0	medium
Tall Fescue	*Festuca arundinacea*	5-8	cool	perennial	bunch	24-36"	1 1/2-3"	wide range, pH 5.3-7.5	medium
Red Fescue	*Festuca rubra*	3-6	cool	perennial	bunch	8"	3/4-1 1/2"	wide range; low pH	low
Perennial Rye Grass	*Lolium perenne*	3-7	cool	perennial	bunch	12-24"	1 1/2-2 1/2"	wide range	medium-low
Kentucky Bluegrass	*Poa pratensis*	3-7	cool	perennial	rhizome, creeping	12-24"	3/4-1 1/2"	fertile loam, pH 6.0-7.5	medium
Zoysia Grass	*Zoysia japonica*	6	warm	perennial	stolon, rhizome, creeping	12"	1/2-1"	well-drained, pH 5.5-7.0	medium

Table 6.1 - Turfgrass Selection continued

FERTILIZING TIME	MOISTURE REQUIREMENTS	LIGHT REQUIREMENTS	HOW ESTABLISHED	ESTABLISH-MENT TIME	RATE OF SEEDING (#/1,000 SQ. FT.)	RATE OF PLUGGING	WHEN TO ESTABLISH
3-4 x/year	good drought tolerance	full sun	seed or plug	rapid	2-3	6-12" apart	early summer
late fall, early spring	excellent drought tolerance	sunny; somewhate shade tolerant	seed	rapid	4-8 (K-31) 10-12 (Turf-type)	not applicable	early fall
late fall, early spring	good drought tolerance	sun or shade	seed	moderate	3-5	not applicable	early fall, early spring
early fall, early spring	not very drought tolerant	sunny; not very shade tolerant	seed	rapid	4-6	not applicable	early fall
early spring, early summer, early fall	not drought tolerant	sun in north; shade in south	seed	rapid	2-4	not applicable	early fall, early spring
early spring, mid. summer, early fall	excellent drought tolerance	sun to part shade	stolon	slow, 6-9 months	usually vegetatively propagated	6" apart	May

Table 6.1 - Turfgrass Selection continued

COMMON NAME	TEMPERATURE TOLERANCE	DISEASE PROBLEMS	INSECT PROBLEMS	USE	TEXTURE	COLOR	OTHER COMMENTS
Bermuda Grass	high heat	dead spot; brown patch; dollar spot	none important	parks; football fields; homes	fine	dark blue-green	salt tolerant; goes dormant
Tall Fescue	heat tolerant	leaf spot; brown patch; resistant to most diseases except snow mold	not many unless heavy populations; army worm; grubs; sod-webworm	utility; roadways, athletic fields, erosion prevention	coarse-wiry	medium green	
Red Fescue	not heat tolerant	fungus	none important	lawns	fine	dark green	don't over feed
Perennial Rye Grass	not heat tolerant	leaf spot rust	any worms; sod-webworms	lawns; high traffic areas	medium to coarse	bright green	sheaths have pinkish color
Kentucky Blue Grass	80°F	moderately resistant to most cool season diseases	grubs; cinch bugs; sod-webworms; cut worms; army worms	sunny lawns; athletic fields; parks	medium	blue-green	resistant to leaf spot
Zoysia Grass	high heat	nematodes; brown patch; dollar spot; Pythium	mole crickets; sod-webworms; Billbugs; grubs; army worms; mites; scales	golf course sand traps; lawns	medium	medium green	low maintenance; grows above 60°F

Landscape designing includes communicating a design proposal to a client. This proposal is prepared on paper as a landscape plan for a particular site. To effectively compose a design; the designer must use the elements of design; which are texture, form, color, and line.

Texture

Texture is the fineness or coarseness of a plant. It is determined by comparing the textures of surrounding plants in the landscape. The physical features of a plant, such as the size of the plant, foliage, branches, bark, and buds, help in the determination of texture.

Foliage plays an important part in texture. Simple leaves are usually coarse, whereas compound leaves are fine-textured. Leaf margins or edges, and the smoothness or roughness of leaves, also indicate texture. The arrangement of the foliage may influence the texture as well. If the foliage is thick the texture will seem fine, and if the foliage is wide and open the texture will seem coarse.

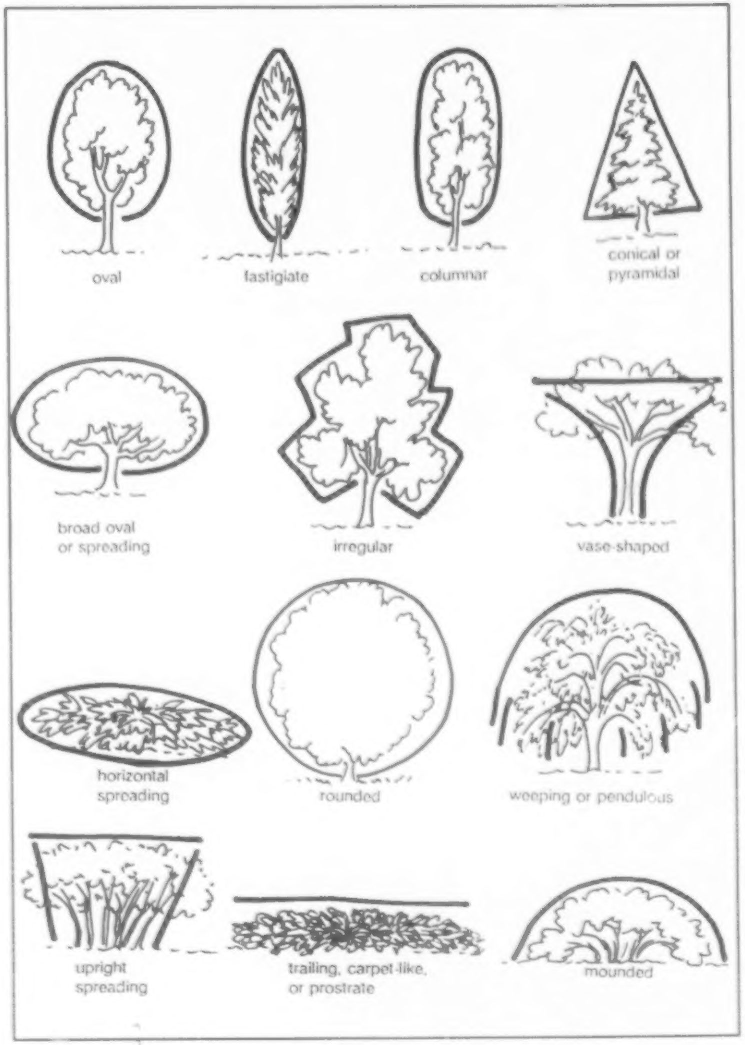
Texture can be used to create an illusion of depth. Fine texture helps to create a receding appearance, while coarse texture seems to advance. The farther away a plant is, the finer the texture appears. Coarse plants are better placed in the foreground and fine-textured plants in the background. In addition, combining lighting and shadowing with texture can help create depth in a design.

Form

The form of a plant is its three-dimensional shape. Three-dimensional shape is the outcome of the natural growth habits of the trunk, branches, and foliage. See Figure 1.1 for basic plant forms.

Most plants are more rounded and horizontal in form than vertical. Vertical forms tend to stand out and dominate the landscape. Plants which are grown in their natural habitat and terrain have a tendency to follow the form and the contour of the land.

Figure 1.1 - Basic Plant Forms


oval
fastigiate
columnar
conical or pyramidal
broad oval or spreading
irregular
vase-shaped
horizontal spreading
rounded
weeping or pendulous
upright spreading
trailing, carpet-like, or prostrate
mounded

Form or shape of the area to be landscaped must also be considered in creating an effective design. The shape of the area is depicted by the plant forms and their placement in the landscape.

Form or shape is also created by how plants are grouped. A group of plants can take the form of individual plants. Too many different forms in a landscape can create chaos.

Color

Color creates excitement in the landscape. Color is found in the foliage, branches, bark, flower, and fruit of plants. When choosing color for the landscape, foliage color should be considered first because it is the color that lasts the longest.

Color combinations may vary because of many environmental factors. The most common factor is the changing seasons. Other factors are weather conditions, time of day, distance, light intensity, and background against which the color is placed.

Yellow, red, and orange are warm yet bright, inviting, and lively colors which seem to advance. Cool colors such as violet, blue, and green recede and help create a restful mood. Colors should be selected to complement the theme of the design.

Line

Line is the intersection of two planes; it also outlines or silhouettes a form or shape. Lines can be curved, horizontal, or vertical.

Line can create a visual as well as physical direction. One's eye can follow the line of a landscape that gives an illusion of depth or height. Physical line defines circulation patterns and space throughout the landscape. Line can create a feeling of formality when straight, and one of naturalness when gently curved. Intersected lines give a feeling of hesitation.

Emotion

When design elements are effectively used in a landscape, they can stimulate many emotions in people.

Size - The size of a plant or group of plants can make an area appear smaller or larger than it actually is. Anything that is larger than the normal size may stimulate an uneasy or scary feeling. Anything smaller than normal may stimulate an inferior feeling.

Line - Line may stimulate many emotions. Horizontal lines promote a sense of tranquility and peace. Curved lines seem gentle and flowing, whereas vertical lines seem dignified and strong.

Color - Color may have more of a psychological effect on people. Hues are pure colors. Tints are hues with a touch of white to soften a color, thus helping to create a happy mood. A peaceful feeling may be created by adding gray to a hue to make a tone. A sad feeling may be created when mixing black with a hue to make a shade.

Summary

The design elements of texture, form, color, and line are important factors in creating a compositional landscape design. Texture gives fine, medium, or coarse definition to plants. Form is the three-dimensional shape of plants. Color adds to the visual appearance of the design. When used properly, the elements of design help create feelings of harmony and completeness.

Credits

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Most people believe a landscape is created by using only different kinds of plants, but there is more to a landscape than just grass, trees, and shrubs. Besides plants, there are other natural as well as many manufactured items that can be added to a landscape to enhance its attractiveness and monetary value.

Purposes

Natural enrichments can be added to enhance the landscape. Many wonderful ideas can be aesthetically created with natural elements. For example, the feeling of a wooded countryside can be implemented into the landscape by using natural enrichments. Natural enrichments can attract wildlife to an area as well, enhancing it further.

Natural enrichments create beauty and serenity in the landscape by adding a touch of nature. Natural enrichments already found on-site may be used or they may be brought from off-site areas.

Manufactured enrichments are any items that are created through a manufacturing process. There is a wide range of manufactured enrichments that can be added to the landscape.

The purpose of manufactured enrichments is to add unity and harmony to the landscape plan. Care must be taken not to clutter the landscape with manufactured enrichments. There are three, general rules to follow when adding manufactured enrichments to the landscape.

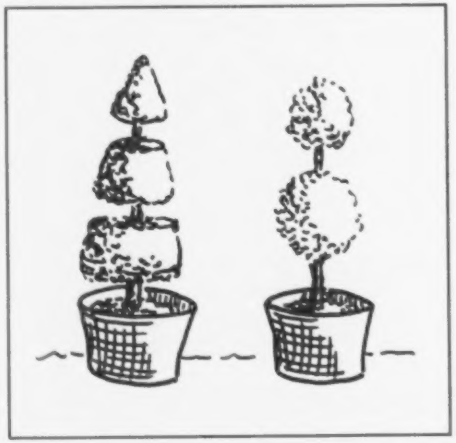
1. Make sure the enrichment fits the environment.
2. Use the enrichment as a focal point.
3. If the enrichment looks awkward, remove it.

Natural enrichments

A natural enrichment that is already an attribute on the site can be used in the landscape. Natural enrichments can also be moved from their natural settings to the landscaped area. They can be either tangible; touched and seen, or intangible; appealing to the other senses of smell, taste, and sound.

Tangible enrichments - Some tangible, natural enrichments are boulders, stones, logs, and rocks. Mulch, bark, and gravel fit into this category as well. Other natural enrichments are plants. Plants can be chosen for their special colorings or growth habits. Topiary is the practice of pruning trees and shrubs into unusual shapes and forms and is found in many formal gardens. See Figure 2.1. Topiary is not very commonly used because it requires a lot of maintenance.

Figure 2.1 - Topiary



Intangible Enrichments - Some examples of intangible natural enrichments found in landscapes are the fragrance from flower beds and blooming trees, the sound of wind blowing through trees, and the taste of fruit and vegetables from trees and gardens.

Water and animals are both tangible and intangible natural enrichments. Natural ponds or creek beds running through the landscape can add beauty and serenity with their sound. Animals, especially songbirds and scurrying small animals, can bring the landscape to life with song and movement.

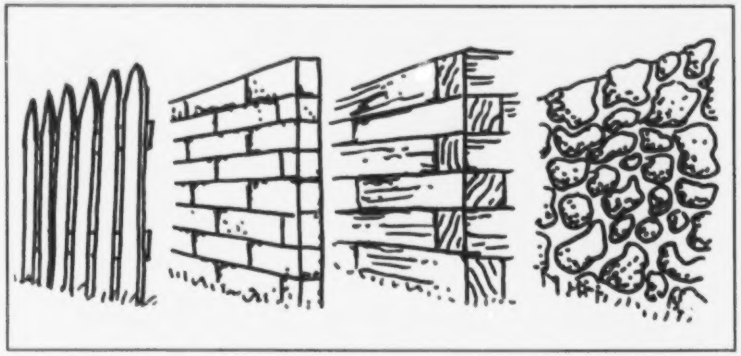
Considerations of Selection

Natural enrichments bring natural beauty to the landscape. But special considerations must be made before designing with natural enrichments. Natural enrichments chosen for a landscape should fit into the theme of the design. Special care should be used when selecting plants for a landscape. Certain flowering trees and shrubs may irritate allergies. Some plants can attract unwanted animals to the landscape. Attracting animals such as rabbits or squirrels might cause damage to flower and vegetable gardens.

Manufactured Enrichments

Many kinds of manufactured construction materials can be used in landscaping. For example; a wall or fence might be made of concrete, wood, chain link, railroad ties, brick, or stone. See Figure 2.2 for examples. All are manufactured materials that are efficient and attractive in a landscape.

Figure 2.2 - Sample Enclosure Materials



Types of Manufactured Enrichments

There are many types of manufactured enrichments that can be added to the landscape. The four most common types are outdoor furniture, outdoor art, pools and fountains, and night lighting.

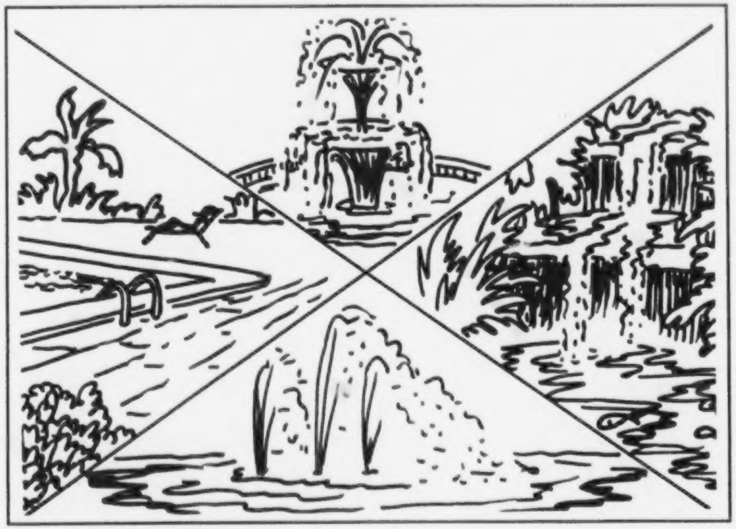
Outdoor furniture - Outdoor furniture comes in a variety of styles and materials, from wooden to iron rod. It can be permanently placed in the landscape, or it can be moveable. Such items of furniture might be chairs, picnic tables, lounges, benches, and playground equipment.

Outdoor art - Outdoor art adds a touch of personal taste to the landscape. Everything from sculpture, such as a bird bath or a statue, to a mural painted on a wall is considered outdoor art.

Fountains and pools - Fountains and pools are becoming more popular as a manufactured enrichment to the landscape. Fountains are used often to enhance a plaza area and are also commonly found in formal gardens. Swimming pools can be either above-or below-ground. An installed pond is considered a pool as well. Ponds are popular for recirculating water in a patio area. The main disadvantages of fountains and pools are high maintenance and cost of installation. See Figure 2.3.

Night Lighting - There are many benefits of adding night lighting to a landscape. Night lighting provides safety and security, by helping

Figure 2.3 - Fountains and Pools



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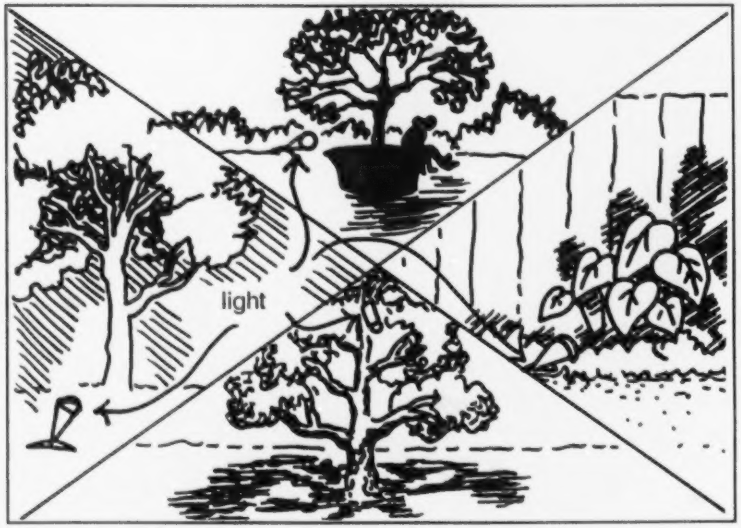
guide people through walk areas. It allows greater nighttime use of the landscape, and creates special effects. There are two general rules to follow when using night lighting. First, always use a light intensity outside that is equal to the light intensity inside in order to prevent glare. Second, be careful not to place lights so they shine in people's eyes. Some examples of different styles of night lighting follow. See Figure 2.4.

1. Silhouette lighting is placed behind plants to outline them.
2. Shadow lighting is placed in front of the plants, casting shadows from the plants onto objects behind them.
3. Down lighting is placed high, casting patterns of light and leaf shadows onto the ground.
4. Up lighting is placed low to illuminate the plant.

Figure 2.4 - Night Lighting



Outdoor Surfacing Materials

Outdoor surfacing materials are used to cover exposed soil, aid in controlling erosion, and help reduce compaction. There are four different types of outdoor surfacing materials, but only one type is manufactured. Turf, ground covers, and flowers are natural outdoor surfacing materials, while paving material is manufactured. See Table 2.1 on the following page.

Paving is mainly used in areas of the landscape where there is a lot of car and/or pedestrian traffic. Examples of such areas include sidewalks, patios, driveways, and entryways.

There are two types of paving materials: hard and soft. Hard paving materials have the advantage of being durable, strong, and require low maintenance. The disadvantages are high expense and greater heat absorption. Some examples of hard paving materials include brick, stone, concrete, tile, and paving blocks. Soft paving materials are lower in cost of installation and easier to install and replace. Disadvantages of soft paving materials are that they are less durable and require more maintenance. Soft paving materials include asphalt, crushed stone, sand, marble chips, and gravel.

Summary

Natural and manufactured enrichments can add harmony and unity to the landscape. Natural enrichments can bring nature one step closer to a home through landscape design. Manufactured enrichments can add safety and security; comfort; and enjoyment; through the use of outdoor furniture, outdoor sculpture, pools, fountains, and night lighting.

Credits

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Table 2.1 - Comparison of Types of Surfacing Materials

Surfacing Type	Walking Comfort	Use Intensity	Seasonal or Constant Appearance	Installation Cost	Maintenance Cost
flowers	N/A	lowest	seasonal	moderate	high
turf grass	high	moderate	constant	lowest	high
ground cover	N/A	low	seasonal	moderate	moderate
soft paving	moderate	moderate	constant	moderate	moderate
hard paving	lowest	highest	constant	highest	low

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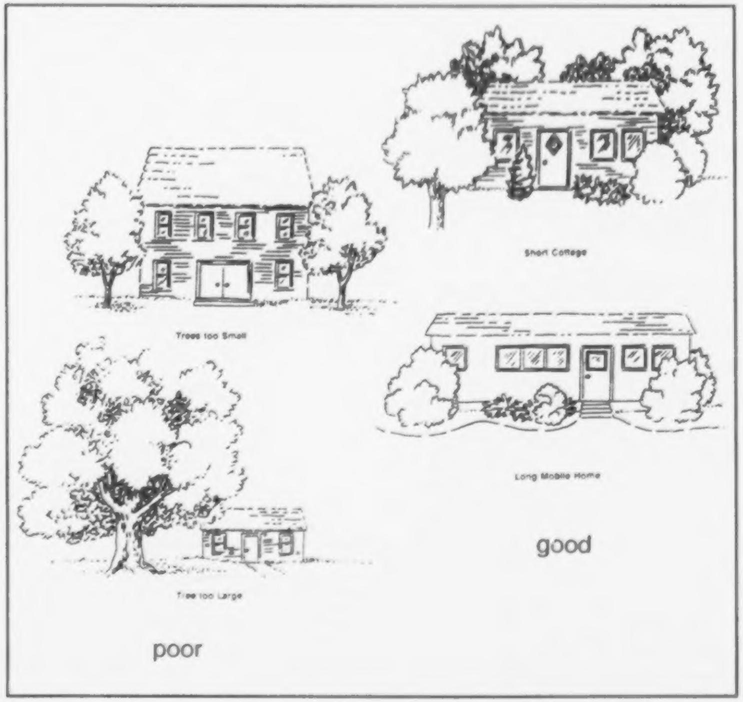
Hoover, Norman K.; Elwood M. Juergenson. Approved Practices in Beautifying the Home Grounds. Danville, IL: Interstate Printers and Publishers, Inc., 1973.

A landscape design that is appealing and attractive is not achieved by accident. It is achieved by using the design elements harmoniously through the laws or principles of design. The principles of design are scale and proportion, balance, rhythm, simplicity, and focal point.

Scale and Proportion

Scale and proportion go hand-in-hand, yet they are slightly different. Scale is the comparison of size of one part to another part, or one plant to another plant. Proportion is the overall size of the plantings to the buildings or area to be designed.

Figure 3.1 - Scale and Proportion



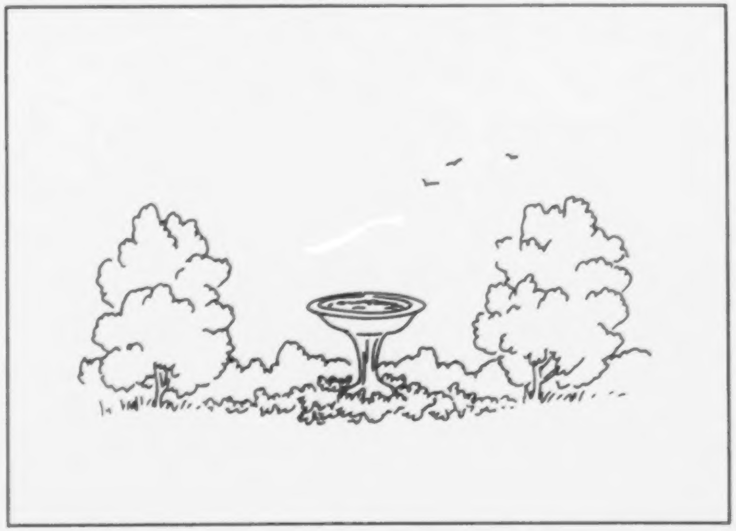
Since a landscape is designed for people, the general determinate of scale and proportion when designing it should be the size of a human. The size of the area to be designed as well as the different activities taking place in it also can help determine the scale and proportion of the plantings. Mature plant sizes need to be considered when designing a plan. If plants outgrow their area, scale and proportion will be out of balance in the compositional design. See Figure 3.1.

Balance

Balance is the equality of visual sight and physical weight, and creates a feeling of stability. If an imbalance exists in a landscape, a dissatisfied or uncomfortable feeling may occur. There are two types of balance; symmetrical and asymmetrical.

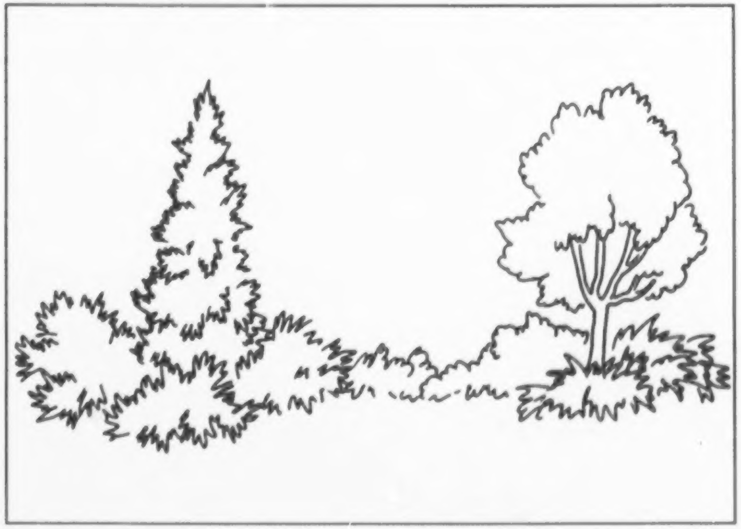
Symmetrical Balance - Symmetrical balance is a mirror image of one side of an axis to the other side of the axis. It gives a formal appearance as well as equal importance to each side. See Figure 3.2.

Figure 3.2 - Symmetrical Balance



Asymetrical Balance - Asymmetrical balance is equal physically but not visually. Asymmetrical balance gives an informal appearance and occurs more frequently in nature than symmetrical balance. A good way to create asymmetrical balance in the landscape is to use odd numbers of one, three, five, or seven plants. Asymmetrical balance creates contrast with size, shape, and form. See Figure 3.3.

Figure 3.3 - Asymmetrical Balance



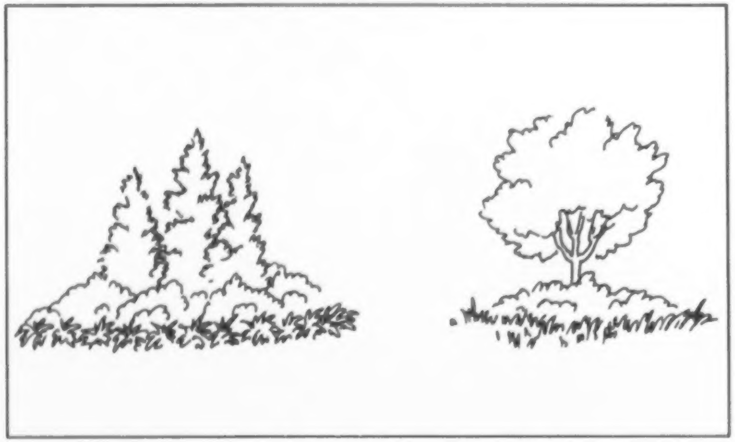
It is important to remember that balance is not viewed from one or two different places, but rather from every point of view on-site and off-site. Color and texture play an important role in balance. Too much of a color in one area, such as red, can create a feeling of imbalance. If the red color is scattered throughout the design, there is balance. This is true with texture as well.

Rhythm

Rhythm, sequence, or repetition is the repeating of the design elements to create eye-movement throughout the design. Rhythm helps achieve harmony and unifies the design. However, too much rhythm or repitition will result in monotony.

Rhythm can be achieved by using simple, free-flowing lines; gentle curves; gradation of one color to another or one texture to another; repeating lines or forms of the area; or designing by using plants with the same line or form of the area or building. See Figures 3.4 and 3.5.

Figure 3.4 - Sequence



Simplicity

Simplicity can achieve elegance by creating a harmonious but simple design. Too much of any one element of design can create a chaotic, complicated design with too much repetition occurring in the landscape.

Simplicity is easily achieved by using curves instead of straight lines, by avoiding complicated forms or colors that conflict with building or area shapes, or by mass planting instead of using individual plantings. All of these can draw attention away from the overall design.

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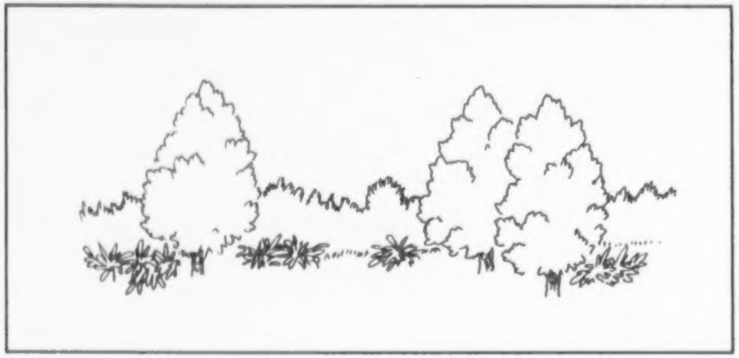
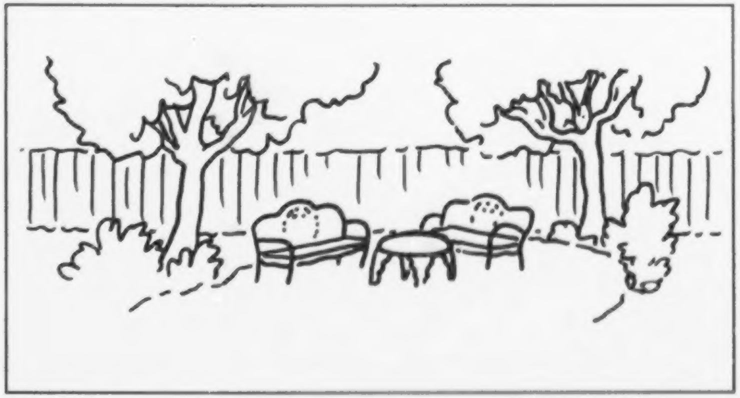
Figure 3.5 - Repetition



Focal Point

The focal point is the point of immediate, visual attraction. It is an object or plant that draws the eye immediately to an area. The focal point is a combination of design elements that create an appealing view.

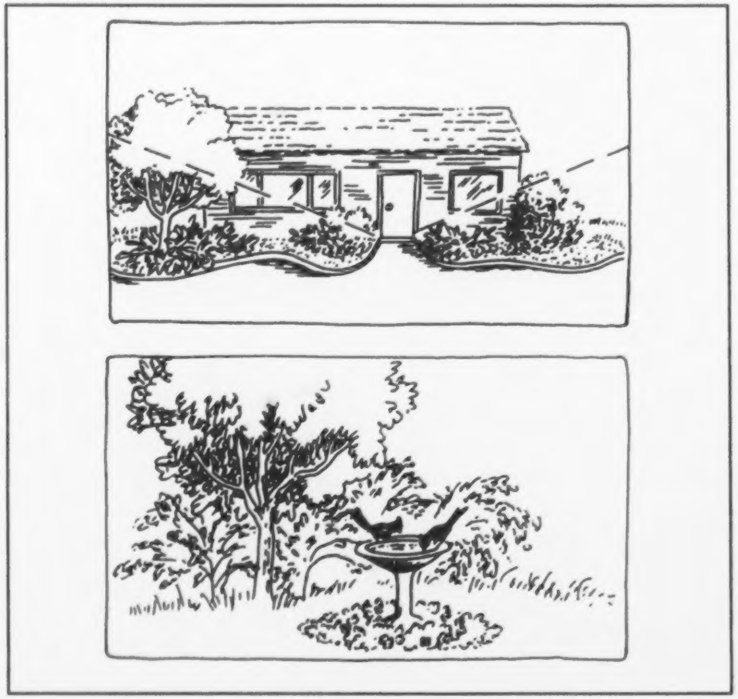
Figure 3.6 - Simplicity



Each use area has a focal point. The public area has only one focal point, the front door. The rest of the public area should be landscaped not to draw attention away from the door, but rather to lead people to the door. The private and service/utility areas can be designed with focal points where the client desires, but there should never be more than one focal point per view in each area.

A focal point is achieved by using rhythm, simplicity, balance, scale, and proportion appropriately with the design elements of line, form, texture, and color. A good example of focal point might be a gazebo or a bird bath. See Figure 3.7.

Figure 3.7 - Focal Points



Summary

The principles of design are the laws or rules used with the design elements to create a landscape plan. Scale and proportion are significant in relation to plants, buildings, and people. Balance is physical weight equality on both sides of an axis but not necessarily equality of visual appearance. Rhythm is the repetition of line, form, texture, and color to unify the design. Simplicity is important in the design in order to prevent confusion and chaos. A focal point is the center of attraction in each use area of a landscape plan. Use of all the design principles will help create an attractive landscape.

Credits

Hannebaum, Leroy G. Landscape Design: A Practical Approach. Reston, VA: Reston Publishing Co., Inc., 1981.

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Landscape design includes three use areas: public, private, and service/utility. Each area is individually designed and serves a specific function. Each area must also be systemically composed so it will blend into the next one.

Focal Point Support

The focal point is the main attraction in an area. It should not be drastic, although able to draw attention. There are three ways to emphasize the focal point: using specimen plants, accent plants, or mass plantings.

Specimen Plants - Specimen plants are trees or shrubs that have a strong, visual feature; but do not draw enough attention to the focal point plant. They usually grow best when planted alone. Specimen plants have strong, visual characteristics in the design elements of color or texture. One example is the Colorado blue spruce.

Accent Plants - Accent plants also have strong, visual features, but are most effective when planted in groups. These plants help create simplicity and are commonly used in corner plantings. A birch tree is an example of an accent plant.

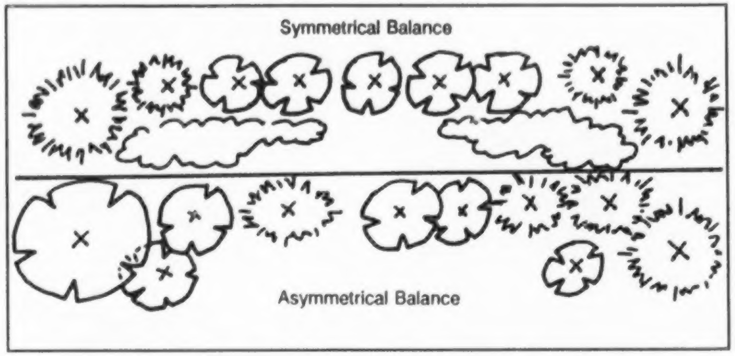
Mass Plantings - Mass plantings are odd-numbered groupings of trees and shrubs which have no strong, visual characteristics when planted individually; although, when planted together in one mass planting, these trees and shrubs lose individual identities and develop strong, visual characteristics as a group. A yew makes a nice mass planting.

Arrangement of Trees and Shrubs

Trees and shrubs can be arranged in the public, private, and service/utility areas in any of three ways: line plantings, corner plantings, and foundation plantings. All plantings are grouped in cultivated beds and mulched. Design elements and principles are used in order to help stimulate imagination and interest in the plantings.

Line Plantings - Line plantings of trees and shrubs can be used to make walls, screens, or enclosures. Line plantings can be composed to block or frame a view. They can give total, partial, or no privacy. To enhance a line planting be careful not to oversimplify, causing monotony; or to create chaos, with too much variety of any design element. A line planting looks appealing when trees and shrubs are put into groups of three, five, or seven. An effective way to make a line planting is to place shorter plants in front of taller ones, and stagger the plants in the line. See Figure 4.1.

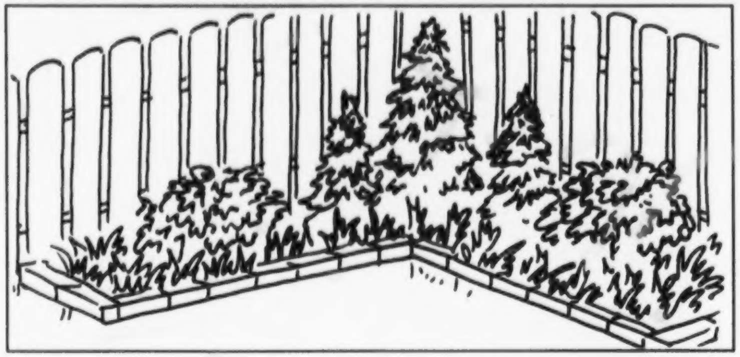
Figure 4.1 - Line Plantings



Corner Plantings - Corner plantings are used at the corners of connecting lines in a landscape plan and are formed with two parts, the in-curve and the out-curve. The in-curve is the center of the planting area where the tallest plant is placed. It is also the area of the planting that will attract most of a viewer's attention. The out-curve is on both sides of the in-curve. Shorter plants are placed at the out-curve with taller plants placed at the in-curve, giving a stair-step effect. Corner plantings can be added to the end of a line planting for a continuous screen or wall effect. See Figure 4.2.

Foundation Plantings - Foundation plantings are placed directly alongside a house. They were very popular many years ago in helping to hide large foundations. Today, homes are built more efficiently and it is not usually necessary to cover the foundation area. Foundation plantings are still used today, but have a different purpose. They help connect the house to the rest of the landscape. Foundation plantings are more effective if they do not stop at a corner of the house, but continue around the corner or into the yard.

Figure 4.2 - Corner Plantings



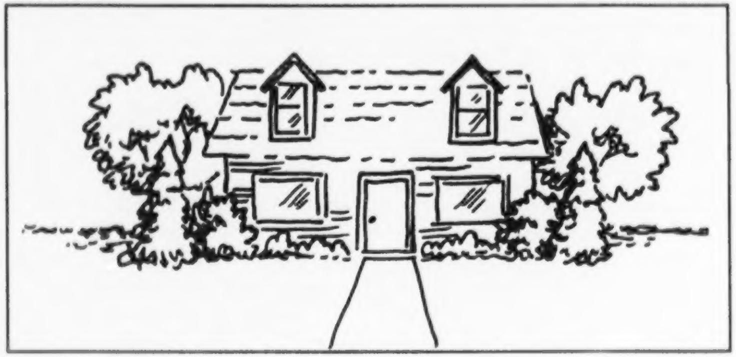
Public Area

The focal point in the public area is the front door and entryway. The landscaping of the public area should be attractive and inviting, easily leading people into the house or building.

The funneling approach is the best way to draw attention to an entrance. The taller plants are placed the furthest from the door. As the plants are placed closer to the door, their heights gradually decrease. See Figure 4.3.

Another approach that can be used to draw attention to the front door is to emphasize the doorway by using manufactured or natural enrichments such as boulders, birdbaths, or driftwood. A strong visual characteristic of form, color, or texture in an accent plant or specimen plant will work as well.

Figure 4.3 - Funneling Approach



Special directives exist for plantings if a sidewalk exists in the public area along the street. City regulations will govern how this area can be landscaped. It is determined by the utility lines that lie below and above ground; any legal limitations that exist; and the width of the strip, the sidewalk, and the street. Other ways of landscaping the public area are using corner, line, and foundation plantings. These can be used to encourage eye movement throughout the entire area.

Private and Service/Utility Area

Opportunity for creativity exists in placement of the focal points in the private and service/utility areas. The focal point should be emphasized, and the remaining area arranged to complement the focal point. How the area is designed depends on the size and shape of the area and how it is to be used.

The private area is a place of privacy and relaxation. It is an extension of a house to the outdoors, often including a patio or deck and an open space for activities. The entire area can be landscaped formally or informally, depending on the client's desire.

The service/utility area may or may not have a focal point, depending upon the actual use and size of the area. It may be partially or totally screened. The private and service/utility areas can be screened and divided to control views into and out of the areas. Screens and divisions aid in traffic circulation. Screens and divisions can be made with line or corner plantings, or constructed from wood or concrete.

Summary

Private, public, and service/utility areas are landscaped by applying the design elements and principles. These elements and principles emphasize the focal point with accent, specimen, and mass plantings. Line, corner, and foundation plantings are three ways to help design the three use areas. These plantings should use an odd number of plants. Special care must be taken in landscaping the front entryway of the public area to easily lead people into the house or building. Private and service/utility areas are free to be designed as the client desires.

Credits

Hannebaum, Leroy G. Landscaping Design: A Practical Approach. Reston, VA: Reston Publishing Co., Inc., 1981.

Landscape Design. University Park, PA: Pennsylvania State University, 1968.

Ingels, Jack E. Landscaping. Albany: Delmar Publishers, 1988.

Ingels, Jack E. Ornamental Horticulture Principles and Practices. Albany: Delmar Publishers, 1985.

Landscape designing is a problem-solving activity involving the written communication of the designer's ideas to the client.

Basic Steps

A problem-solving activity usually has certain basic steps that are used in order to come up with a solution. In the case of landscape design, there is no one correct answer but many.

The basic steps involved in developing a landscape design are analysis of home needs, site analysis, design concept, and the design solution stage.

Analysis of Home Needs - The analysis of home needs is a profile of a client's potential needs and uses for a landscape site. A thorough question and answer session with a client is important to determine the client's needs. A check list would be useful during this step. Remember not to hurry this interview, because it is important to understand thoroughly the client's needs, so that the proper design will be created.

Site Analysis - The site analysis must be completed by visiting the actual landscape site. This is an assessment of the existing physical features of the site roughly drawn in diagram form on paper. Information such as a pleasant view, utility line location, and direction of prevailing winds, is obtained from the site analysis.

Design Concept - The next step is developing the design concept. This is the evaluation of the home needs and the site analyses combined to determine the focus of the design. During this step, the client's needs or desires are roughly sketched. If a client wishes a formal or an informal design, it is drawn through the use of the design principles and elements, such as balance and line. Each of the areas public, private, and service/utility are drawn separately. Line, corner, and foundation plantings are created in the design. The plant material selected at this time is very general and includes items such as small trees, large shrubs, medium shrubs, and ground covers.

Design Solution Stage - The design solution stage is the point at which the details and specifics of implementing the design concept are developed. Individual plants are then chosen by both common and botanical names. In this stage remember to keep in mind the client's desire for specific plant materials, if any as well as the environmental factors of soil, light, hardiness zone, moisture, color, size, and form.

Planning

Planning is a vital step in the process of designing a landscape. First visit the site to talk with the client about activities and needs of the family in order to complete the analysis of home needs. This is followed by a site analysis and drawing the base map.

Implementation

Landscape designers are finished with their portion of a job when installation begins, except for follow-up until complete. The time required to actually carry out the design will vary. Some clients cannot afford to have the entire design installed at one time. Whenever the client can make a payment, a portion of the design is installed.

Other considerations for implementation are seasonal. Warm-season turf is laid in late spring or early summer, while cool-season grasses can be seeded in early spring or early fall. Bulbs, too, are planted at different seasons depending on if they can over winter. Therefore, some are planted in the fall and some in the spring.

Vegetable gardens, like turf, have seasonal crops. Cool-season crops are planted in early spring and early fall. Warm-season crops are planted in late spring and early summer. It is advised to look in planting guides for the best planting time for trees and shrubs since it depends upon each individual specie.

Characteristics

A landscape designer must be able to sell a design to a client. The designer must be friendly and courteous at all times and possess good verbal communication skills in order to effectively present information to the client. The designer should also be flexible enough to make any changes that the client would like during the landscaping process.

All drawings and designs possess the basic requirements of accuracy, neatness, and legibility. Designers must effectively communicate to the client their ideas and concepts. Creativity should shine through the design to the client. The client's needs and desires must be met in the design, but at the same time, it must be within the client's budget.

Summary

Landscape designing is primarily a problem-solving activity. The basic steps to problem solving in a proposed landscape design are; analysis of home needs, site analysis, design concept, and design solution stage. Implementing the design depends on the season that is best for installing the different kinds of plant materials. In order to sell a design, the designer must be capable of effectively presenting it; and the design must possess saleable characteristics, such as neatness, legibility, and ability to meet the client's needs.

Credits

Hannebaum, Leroy G. Landscape Design: A Practical Approach. Reston, VA: Reston Publishing Co., Inc., 1981.

Ingels, Jack E. Landscaping. Albany: Delmar Publishers, 1988.

Landscape Design. University Park, PA: Pennsylvania State University, 1968.

Residential Landscape Design. Manhattan, KS: Kansas State University.

A client needs to know the cost of landscaping his or her home. Costs may include the actual development and drawing of the landscape design, and the implementation of the design. In pricing the design, a designer is primarily concerned with the cost of materials, overhead, and labor.

Cost Estimates and Bids

A cost estimate is an approximation of the total price the client will have to pay. The price should include all steps from beginning to end. An estimate is not a final, set cost but it should be as close to the final cost as possible. One reason an estimate is not a firm price, is because the client may wish to make changes in the design as it is implemented.

Whereas an estimate is an approximation and subject to change; a bid is a complete statement of all materials, labor, and specifications to be completed for a specific, fixed price. A bid is a binding agreement between client and the designer or landscape company. If for some unforseen reason the prices of supplies increase, or the job is delayed, which increases cost; the price is still fixed. A mistake in pricing will cut into profit. Bids should be calculated as precisely as possible. Bids are given when a number of companies are seeking the same job. Usually, but not always, the job goes to the lowest bidder.

Pricing a Landscape Design

The price of a landscape design is the sum of material costs, labor costs, equipment costs, and subcontractor costs. The price of a landscape job is the price submitted for a bid. Overhead costs and profit allowance will be incorporated into the material and labor costs. Overhead costs include salaries, advertising, utilities, rent or mortgage, telephone, insurance, and other such operational costs of the landscape business. The materials cost should be figured on specifications. The materials cost will be based on the landscaper's actual cost to purchase and maintain the plant until sale. It will also include the profit desired for the plant.

Specifications

Specifications are an exact list of the quality standards to be used for each material and procedure in the landscape design. Everything from the plant material used to the mulch used and from how to install a tree to how long it should take is included. Every detail should be covered in the specifications. Species of the plants, when to plant, caliper, height, whether the plant is B and B or bare-root, and the type and amount of tree wrap, are some of the items included in specifications. All specifications should be written into an estimate or bid. This will help alleviate mistakes and miscommunication between client and landscape designer.

Features of a Cost Estimate

Calculating a cost estimate includes a number of items such as; cost of materials, cost of planting plants, as well as any type of additional services that may be involved. The time allowed for creating the design must also be included. Overhead and profit must be added into material and labor costs.

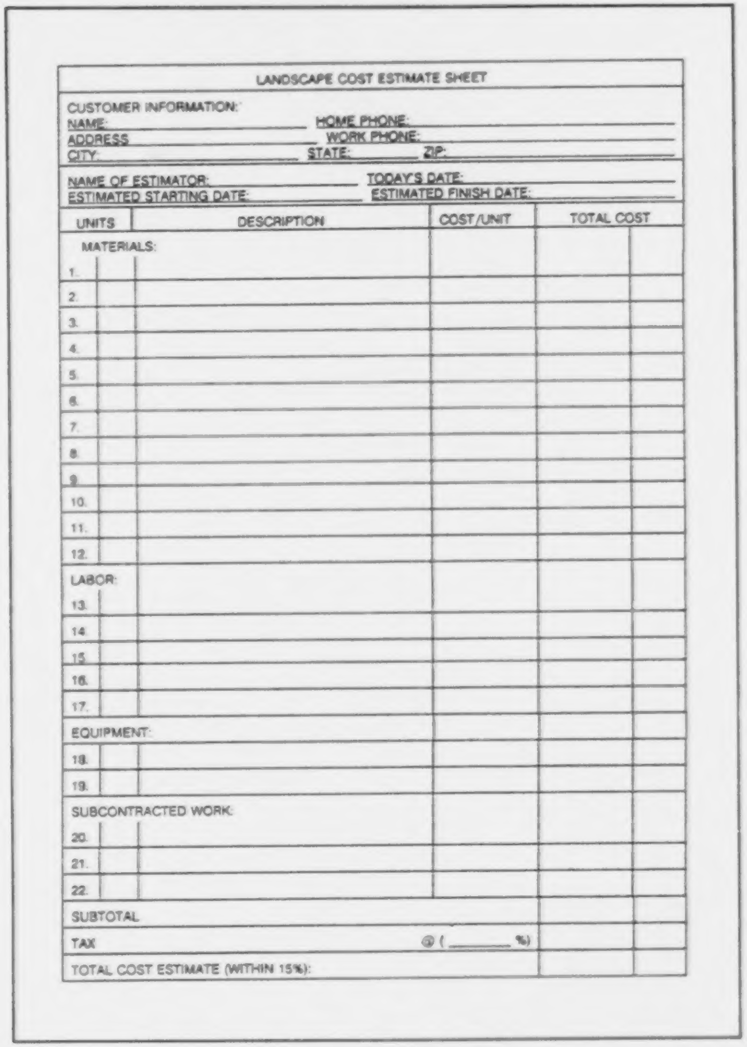
A good way to estimate design and installation costs is to keep a running total from the beginning. A cost estimate should be figured at the same time the design is prepared so that the designer knows the prices of the materials involved. Knowing the cost of labor is also essential. See Figure 1.1 for a sample landscape cost estimate sheet.

Preparing the Cost Estimate

The cost estimate should be figured accurately. All of the materials to be used should be listed under 'Description'; the quantities of each should be listed under 'Units'; and the cost of each under 'Cost/Unit'. The calculated totals go under 'Total Cost'. Material costs may need to be subtotaled to figure labor costs.

Labor costs may be a percentage of the material subtotal. It could also be figured by putting the number of worker hours in the unit column and the type of labor in the description column. The rate

Figure 1.1 - Sample Landscape Cost Estimate Sheet



LANDSCAPE COST ESTIMATE SHEET

CUSTOMER INFORMATION:
NAME: ____________ HOME PHONE: ____________
ADDRESS ____________ WORK PHONE: ____________
CITY: ____________ STATE: ______ ZIP: ______

NAME OF ESTIMATOR: ____________ TODAY'S DATE: ____________
ESTIMATED STARTING DATE: ____________ ESTIMATED FINISH DATE: ____________

UNITS	DESCRIPTION	COST/UNIT	TOTAL COST
MATERIALS:			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
LABOR:			
13.			
14.			
15.			
16.			
17.			
EQUIPMENT:			
18.			
19.			
SUBCONTRACTED WORK:			
20.			
21.			
22.			
SUBTOTAL			
TAX		@ (______%)	
TOTAL COST ESTIMATE (WITHIN 15%):			

charged per hour will include the employees' wages plus overhead costs.

Equipment used is listed under 'Description'. The equipment can either be owned or rented. The number of hours or days needed is listed under 'Units'; and the rate per hour or day is listed under 'Cost/Unit' and the totals in the 'Total Cost' column.

If any work is subcontracted, it is listed in the 'Subcontracted Work' section. Record the task subcontracted under 'Description,' the hours or days of work under 'Units,' and the rate paid for the work under 'Cost/Unit.'

Taxes will vary according to local and state tax rates.

Cost estimate totals should be within 10-15% of the actual costs, as figured at the time the work is performed.

Who Benefits from Cost Estimates?

Both the client and the landscape business benefit from a cost estimate. Clients benefit by knowing how much they will be spending for the product received. The landscaper benefits by knowing that all costs involved have been covered in the price of the design. An estimate also helps to ensure that the design does not exceed the amount the customer is willing to spend.

Determining Quantity

A total quantity of materials is needed to determine the cost of the design. Total quantity of materials is then multiplied by price to determine total price.

Area is determined by different methods for different shapes. Area will be used to determine the amount of seed, sprigs, or plugs needed for a lawn. It is also used to determine the number of ground cover plants needed and to figure the amount of necessary fertilizer.

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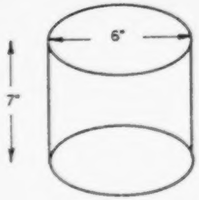
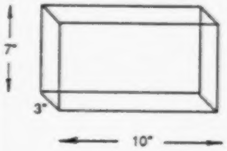
Figure 1.2 - Area and Volume Formulas



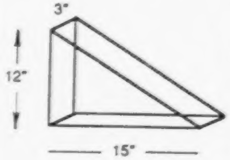
Area of a Circle = πr^2
Example: $3.14 \times 3''^2 = 26$ sq. in.

Volume of a Cylinder = $\pi r^2 h$
Example: $3.14 \times 3''^2 \times 7'' = 197.82$ cu. in.



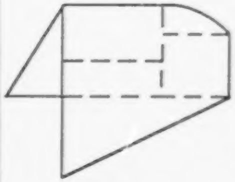
Area of a Rectangle = L x W
Example: 10" x 3" = 30 sq. in.

Volume of rectangular volume = L x W x H
Example: 10" x 3" x 7" = 210 cu. in.



Area of a triangle = 1/2 (Base) x H
Example: 1/2 (15") x 12" = 90 sq. in.

Volume of a triangular volume =
1/2 (Base) x H x W
Example: 1/2 (15") x 12" x 3" = 270 cu. in.



Irregular areas: Try to divide the area into small triangles, squares and parts of circles. It may not be exact, but will give good working estimates.

Conversions:
To convert acres to square feet, multiply by 43,560.
To convert square inches to square feet, divide by 144.
To convert cubic inches to cubic feet, divide by 1,728.
To convert cubic feet to cubic yards divide by 27. (used with concrete and soil)

Volume is determined by multiplying area times depth. Cubic volume is used to determine the amount of gravel or mulch needed to cover a design at a prescribed depth. The amount of soil-amending material, or volume of soil required to cut or fill in grading on a site, can be determined by the formula for volume. See Figure 1.2 for formula for calculating the area and volume of different shapes.

If an area 25' x 15' is to be covered with 3" of mulch, how much mulch would it take to cover this area? First, use all the same units of measure. So convert 3" to feet by converting the inches to a fraction of a foot 3" = 1/4' (12" divided by 3" = 4). Therefore, 25' x 15' x 1/4' = 93 3/4' rounded to 94 cubic feet of mulch needed to cover the area 3" thick. The inches can also be converted to a decimal number, 3" ÷ 12" = .25'. Therefore, 25' x 15' x .25' = 93.75 cubic feet (cu.ft.).

Most of the time, materials are sold in units of cubic feet or cubic yards; so the volume determined may need to be converted to the appropriate unit.

1 cu. yd. (1yd. x 1yd. x 1yd.) = 27 cu.ft. (3' x 3' x 3')

1 cu. ft. (1' x 1' x 1') - 1,728 cu.in. (12" x 12" x 12")

The above answer, found in cubic inches, can be converted to cubic feet by dividing it by 1,728, the number of cubic inches in one cubic foot. 162,000 cu. in. ÷ 1,728 cu.in./cu.ft = 93.75 cu.ft.

It can also be converted to cubic yards by dividing by 27, the number of cubic feet in one cubic yard.
93.75 cu.ft. ÷ 27 cu.ft./cu.yd. = 3.472 cu.yd.

Summary

Pricing the design is an important step in the process of designing. A cost estimate is an approximation of overall costs, whereas a bid is a firm price. Pricing will include costs of materials, labor costs, equipment costs, and subcontractor costs. A cost estimate sheet is used to figure all costs including materials, labor, equipment, and work subcontracted. Overhead costs and profit allowances are incorporated into material and labor costs. Determining quantities of materials needed will be essential in calculating the cost.

Credits

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Peltier, Ruth A. Mathematics for Horticulture. Ohio State University, Columbus, OH: Ohio Agricultural Education Materials Service, 1982.

Service oriented jobs will be in greater demand in the future. Homeowners will be willing to pay for services because they will not have enough time to do the work themselves or they will not want to do the work themselves. Landscape maintenance will be a growing and profitable service.

Cost Analysis

Just as landscape design uses cost estimates and bids, landscape maintenance does as well. The Cost Estimate Sheet from Lesson one, can also be used with landscape maintenance. In general, landscape maintenance will use an overhead figure based on 75% of labor costs and 15% of the total for profit.

There are benefits to using a cost analysis in a landscape maintenance firm. It benefits the client in being charged a fair price for all materials and work completed. A cost analysis can be used to compare the efficiency of different crews in performing the same tasks. All costs to the landscaping firm are acknowledged on the cost analysis.

As a landscape business grows, it may be discovered that some jobs are not profitable. They may not be able to take the time or have the employee force to attend to every task. Therefore, the company will choose those jobs that show the most profit.

Precise record keeping can make analysis of labor very helpful. For example, after being in business for a while, the owner can tell that it takes two crew members four hours to prune a medium-sized landscape. This enables the owner to know how much to charge in the future for a similar job.

Tasks Involved in Landscape Maintenance

Landscape maintenance includes any task required to care for and maintain a landscape after installation. A landscape requires different maintenance at each season of the year. Some of the tasks included in landscape maintenance as follows:

1. Mow lawn.
2. Prune trees and shrubs.
3. Apply fertilizer to lawn and plantings.
4. Control weeds in lawn and plantings.
5. Spray and/or dust to control insects and diseases.
6. Plant and care for flower beds and borders.
7. Replace dead plants.
8. Paint or stain outdoor furnishings.
9. Repair walls and paved surfaces.
10. Clean fountains and pool basins.
11. Irrigate lawn.
12. Cultivate soil around trees and shrubs.
13. Replace mulches.
14. Remove lawn thatch.
15. Roll and reseed lawn.
16. Rake leaves in fall.
17. Winterize trees and shrubs.
18. Remove snow.
19. Perform preventative maintenance on equipment.

Features of a Maintenance Cost Analysis

There are several features listed on a cost analysis that help determine the total job cost. Unit pricing converts all of the dimensions and quantities into the same measurement. This makes it easier to total the job cost. The seven features of a cost analysis are as follows:

1. A listing of all tasks to be performed
2. The total square footage of area involved for each service
3. The number of times each service is performed during the year
4. The time required to complete each task once
5. The time required to complete each task annually
6. The cost of all materials required for each task
7. The cost of all labor required for each task

Figuring Labor Cost

Labor can be figured by dividing an hour into ten parts. One-tenth hour or 0.1 equals six minutes. So 0.5 equals 30 minutes of work. If an employee is paid $5.50 an hour and works 45 minutes, the employee's wage before taxes equals $4.13. Divide 45 minutes by 60 minutes which equals .75 then multiply by $5.50, which equals $4.13 rounded.

45 ÷ 60 = .75 x 5.50 = $4.13

This amount is then charged to the customer as labor cost.

Summary

Calculating a cost estimate sheet will make the client aware of what maintenance tasks will be completed and the cost of completing them. In addition, it will alert the landscape maintenance company of tasks to be completed and the cost of work as well as profit involved. There are many types of tasks involved in landscape maintenance from mowing lawns in summer to plowing snow in winter. A maintenance cost analysis sheet will help to figure the total cost of tasks to be completed. Keeping track of the amount of time required to complete a job is important in figuring wages.

Credits

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